The FOUNDRY

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Accentuates Use of Follow Board

New Plant Equipped with Reference to Special Product Uses Match Plates Extensively—Lessons of Light Shop Have Been Adapted to Heavy Work in Old Plant

BY PAT DWYER

SO MANY radical points of difference obtain in the practice involved in making heavy and light castings that it is rather unusual to find a foundry engaged in the production of both classes of work. The tendency is more and more toward specialization and intensive production. At one time, a foundry simply was a building in which the owner was prepared to make any kind of a casting required; but gradually the castings began to segregate into groups and at the same time the foundry owners began to devote their particular attention to some one of these groups. Familiar examples that will at once come to mind are stoves,

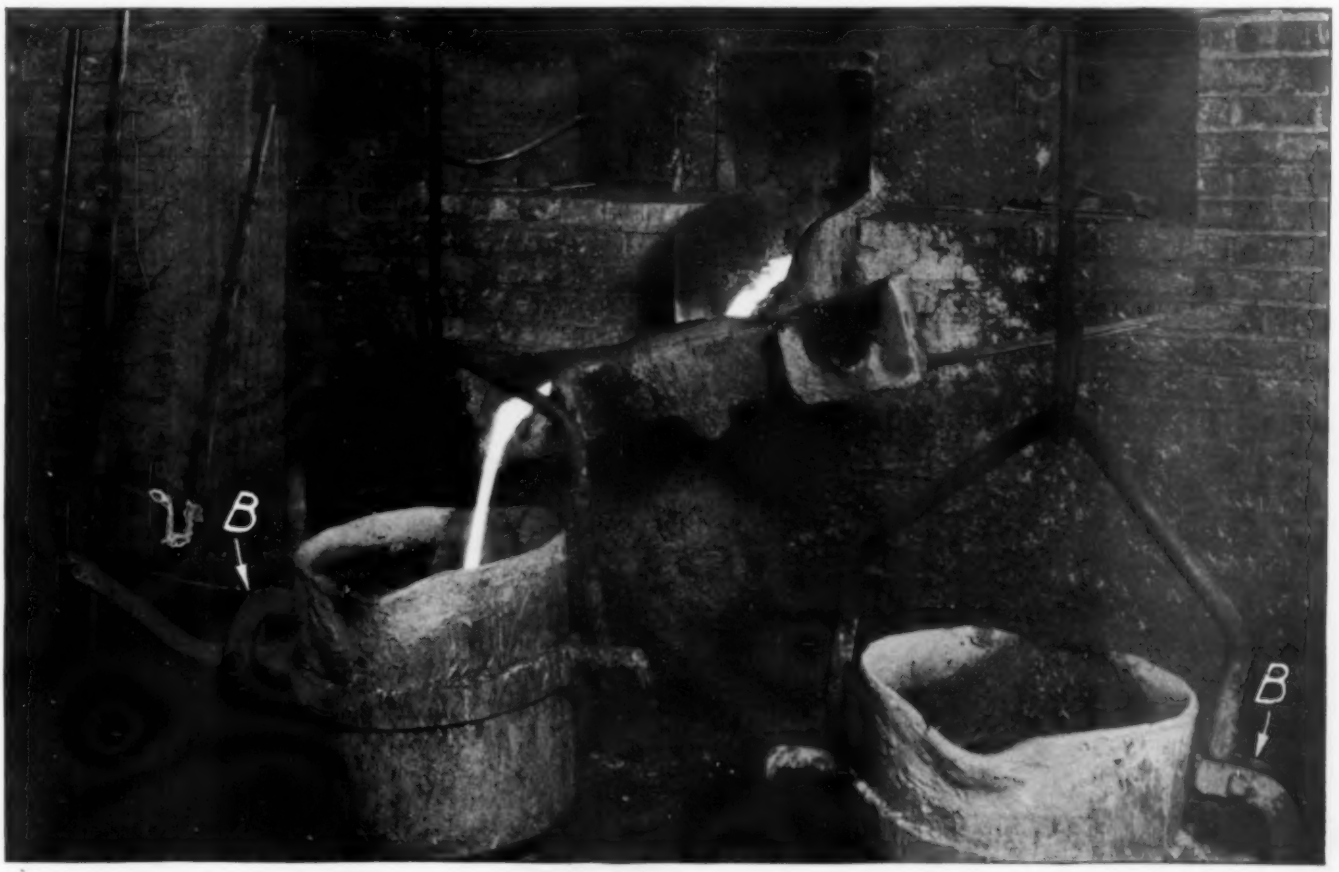


FIG. 1—BY THE USE OF THE TILTING SPOUT AN ALMOST CONTINUOUS STREAM OF METAL CAN BE TAKEN FROM THE CUPOLA—WITH SEVERAL LADLES SUSPENDED FROM THE MONORAIL A SECOND LADLE ALWAYS IS AVAILABLE BEFORE THE FIRST ONE IS FILLED

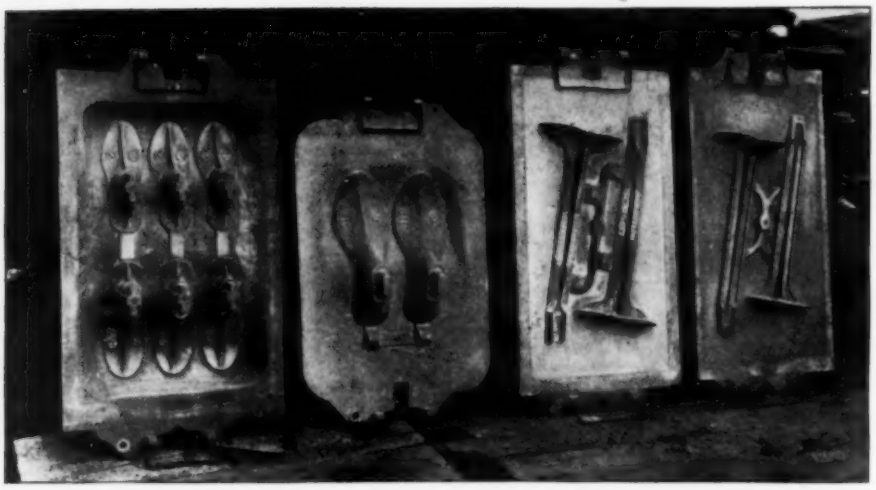


FIG. 2—TYPICAL MATCH PLATES—NOTE THE HOLE NEAR THE LOWER LEFT HAND CORNER OF EACH FOR ATTACHING THE VIBRATOR

radiators, soil pipe, water pipe, ingot molds, sash weights, agricultural machinery and within recent years automotive castings.

New foundries were built and equipped with particular reference to the requirements of some single product and old foundries were made over and adapted in like manner. In some instances, the old foundries were retained and used for the production of miscellaneous castings while an entirely new part was erected and equipped for the production of some specialty in which the foundry company was interested. The Fate-Root-Heath Co., Plymouth, O., is an interesting example of the latter type.

The J. D. Fate Co. and the Root-Heath Co., formerly conducted independent establishments, but through a combination of circumstances, they finally came under one management. The J. D. Fate Co. was a manufacturer of heavy machinery, gasoline locomotives, clay working machinery, etc., and had its own well equipped foundry for the production of the castings. The Root-Heath Co. specialized in shoe repairing machinery, lawn mowers and other small work of a like character. The latter company operated a small foundry where some of the castings were made and the remainder were purchased outside.

Upon the amalgamation of the two companies, it was decided to build an addition on the existing foundry to take care of the overflow work and also to fit it up in a special manner for the production of light castings. To all intents and purposes the company operates two foundries, one for its light work and one for the heavy work. Each foundry has its own crew of men, its own cranes, flasks and other equipment including its own cleaning room. The only factors they share in common are the melting equipment and the core room. One general foreman looks after the two shops.

The old shop is used exclusively for the heavier castings entering into the machinery manufactured by the company; but some of the ideas and methods that have been found advantageous in molding the light castings have been introduced into the old shop with success. For example, instead of bedding some of the large jobs in the floor, or of laying them on the first convenient sized bottom board to roll them over, the patterns are mounted on specially prepared, planed, rollover boards. This obviates the necessity for making a parting after the flask has been rolled over. The boards are provided with several sets of dowel holes and therefore can be used for any pattern within the capacity of the flask.

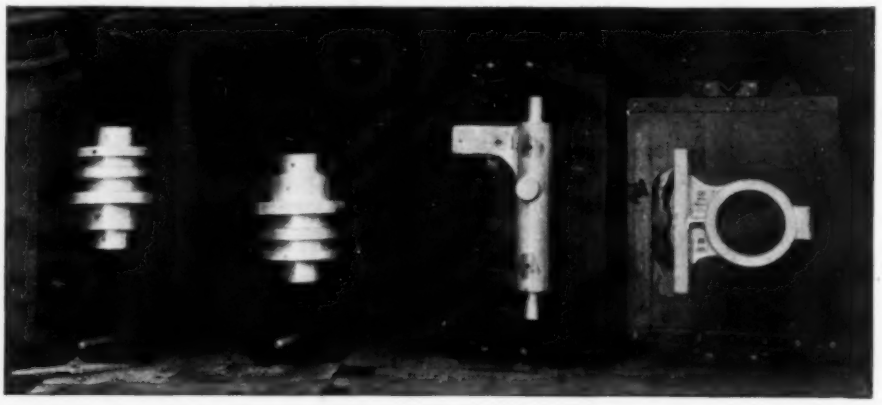


FIG. 4—FURTHER EXAMPLES OF WOODEN PATTERN PLATES—NOTE THE SUBSTANTIAL CHARACTER OF THE GUIDES AND PINS ON THE RIGHT HAND BOARDS

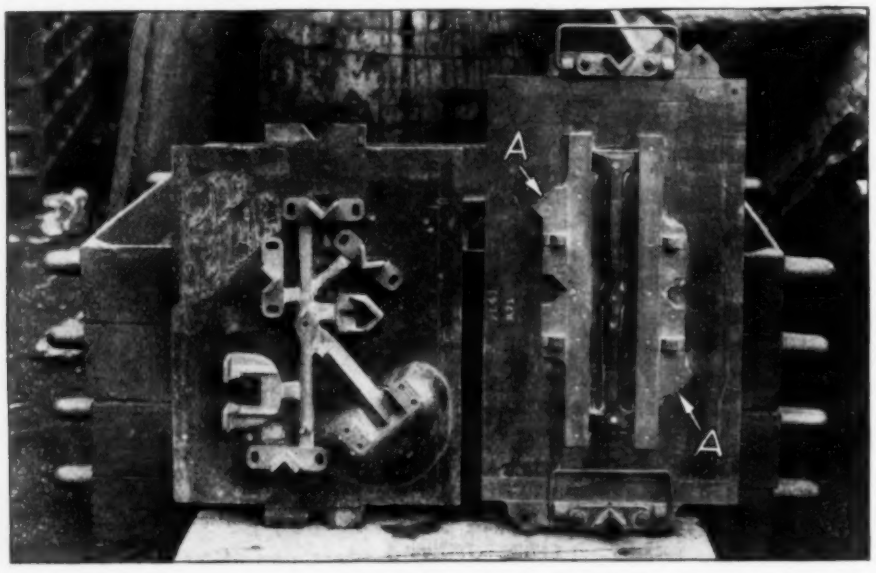


FIG. 3—PATTERNS FOR GUIDES, PINS AND REINFORCING STRIPS USED IN FITTING UP WOODEN MATCH PLATES

Where a split pattern is employed it is customary to mount each half on a board in preference to ramming the cope on top of the drag. This method possesses two advantages. It makes a perfect joint on the mo'd and eliminates to a great extent any unsightly fins and also, if necessary, it furnishes an opportunity to put two men or two gangs of men at work on a job at the same time. No foundryman of experience needs to be told that one man or one gang of men will do more

work in two days than two men or two gangs of men will do in one day. Mathematically two men multiplied by one day are equal to two days multiplied by one man but in practice it does not work out that way.

Many of the castings made in the old shop are bulky and intricate and do not lend themselves readily to machine molding methods. This condition together with a second factor that no long orders involving large quantities of duplicate castings are customary, accounts for the fact that all the molds are rammed by hand. A highly skilled class of molders is employed in the old shop. The new shop is equipped throughout with molding machines operated by handy men recruited from the neighborhood.

Handling the Iron

Formerly the old shop had its own cupola, but after the new shop was built a new cupola was installed with a capacity sufficient to supply iron for the two shops. The iron is brought from the cupola on a monorail having a branch running into the old shop at one end. A 5-ton crane in the main bay and a 1-ton hoist in each of the side bays, all three made by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., facilitate the pouring of the iron. For pouring the larger castings, a pit has been provided near the end of the shop at which the monorail enters and within reach of the traveling crane. A large ladle is set in this pit and filled from a succession of small ladles carried on the monorail from the cupola. After a sufficient amount of iron has been collected in the ladle it is picked up by the traveling crane and taken to the waiting mold or molds. A cleaning room, located at one end of the old shop is used for cleaning the heavy castings. It is provided with a monorail hoist which conveys the castings from the foundry and also with a sandblast room installed by the W. W. Sly Co., Cleveland. The smaller castings are cleaned in a separate building which has been erected in connection with the new shop and which will be described in detail later.

Part of one of the side bays in the old shop is used as a core room. It is provided with a large oven supplied by the Foundry Equipment Co., Cleveland, fired with coke, and two small portable ovens for drying the smaller cores. The sand is mixed in a core-sand mixing machine made by the Wadsworth Core Machine & Equipment Co., Akron, O., and also in a machine made by the Standard Sand & Machine Co., Cleveland.

The new shop, which is approximately 120 x 200 feet, adjoins the old shop at one end. It was erected and equipped with special reference to the economical production of miscellaneous light castings. This plant specializes in shoe repair and lawn mower castings as may be seen from the illustrations showing the grinding and stock rooms, Figs. 8 and 9; but a large amount of general work also is handled.

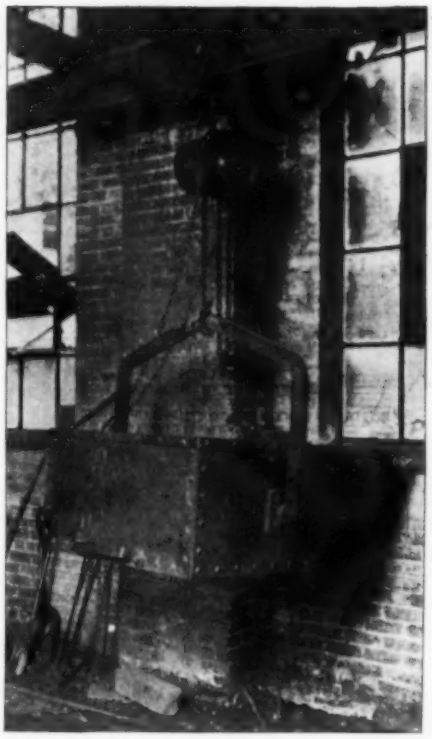


FIG. 5—PAN EMPLOYED FOR CARRYING SCRAP AND CASTINGS

The building is divided into three bays by two rows of columns supporting the roof. The columns are made of wood, but to protect them from deterioration each is set upon an iron plate which in turn rests on a concrete pedestal about 3 feet high. Part of the monorail system which extends all over the plant, is arranged in a loop which embraces the two outside bays. A third branch or spur connected with the loop by a suitable turntable extends down the center bay. The outside loop at one point passes directly in front of the cupola and ladles filled at this point may be conveyed easily and quickly to any point on the molding floor.

Monorail Handles Castings

In addition to conveying molten iron, the monorail is employed for taking castings to the cleaning room and also for taking gates and scrap to the cupola. The type of hoist and pan used for this purpose is shown in Fig. 5. A narrow gage track extends across the floor at one end of the building and connects by turntable with a track leading to the cupola elevator and also to the sand storage shed. This also is used for carrying scrap and refuse out of the shop and for bringing new sand into it. All the dirt from the cleaning room and also all the material from the cupola drop are passed through a large tumbling barrel and later over a magnetic separator made by the Dings Magnetic Separator Co., Milwaukee, Wis. This device reclaims all the iron and the remainder of the material is taken on a narrow gage track and dumped into a hollow place on the company's prop-

FIG. 6—THE SAFETY CATCH SHOWN AT *B* IS UNDER CONTROL OF THE MAN POURING THE LADLE OF IRON

FIG. 7—A CHAIN BLOCK SUSPENDED FROM THE MONORAIL OVER EACH BATTERY OF TUMBLING BARRELS IS EMPLOYED FOR DUMPING THE PANS LOADED WITH CASTINGS INTO THE BARRELS

erty which apparently will not be filled for many years.

Instead of supporting the main air line, supplying the molding machines, along the walls or in tunnels under the floor as is customary in many foundries, a branch of the main air line is attached to the beams directly above the center of each bay. From the main line a section of 1-inch pipe provided with a suitable hose connection at the lower end hangs suspended within easy reaching distance of the man working on each floor. With this arrangement a molding machine may be operated the full length of the floor with a minimum length of hose.

A considerable amount of work is rammed on the bench by hand, but the greater part is made on squeezing machines. Several of the stripping plate machines were built in the company's shops from designs worked out by P. H. Root who in addition to being a skillful patternmaker, also is manager of the foundry and secretary of the company.

All Patterns Mounted

Practically every pattern in the shop is mounted either on a stripping plate, a match plate or a follow board. Many of the match plates are made of aluminum, but a considerable number are made of cherry with cast iron reinforcing strips checked in at the ends. It is claimed that some of these cherry match plates have been in use for five years and apparently are as good as ever. Typical plates, both wood and metal, are shown in Figs. 2, 3 and 4. An interesting feature in connection with these match plates is the wire handles attached to each end for lifting the match plate off the mold. In the metal match plates shown in Fig. 2 it will be noted that the handle lugs are cast integrally with the plate while in Figs. 3 and 4 it is apparent that they form part of the reinforcing strips which are checked into and screwed to the ends of the wooden plates. In either case the lugs for the handles are placed on the side of the plate which comes into contact with the joint of the flask. Thus when the match plate and flask are rolled over, the handles will be on the under side of the plate. To draw the plate and pattern, the handles are pulled out horizontally and not vertically as one might assume from a hurried glance at the illustrations just referred to.

Flask Fittings

The match boards and patterns for making the flask fittings are shown in Fig. 3. After the castings are cleaned a hole is drilled at the points marked *A.A.* This is for attaching a vibrator when the casting is in use on a match plate. Holes also are drilled in the lugs for attaching the wire handles. The wires are bent in a suitable former and are easily sprung into place. The strips are made to a standard length, 14 inches, and will fit all plates that width and wider. If it is necessary to use them on narrower plates, the ends easily may be cut off. They are 3/8-inch thick and are fastened to the match plate with from seven to nine 3/4-inch or No. 10 wood screws. The holes in the lugs are drilled with a 13/64-inch drill and the handles are made of 3/16-inch rod.

The patterns are stored in a 2-story concrete pattern vault adjoining the foundry building. The vault is fitted up in the usual way with shelves divided into compartments and numbered. Each pattern or match plate is stamped plainly with a number which indicates its resting place when not in use in the foundry. An additional number indicating the size of the flask to be used with it is just another of the many little time saving practices of this foundry.

The aluminum for making the match plates is melted in an ordinary babbitt

FIG. 8—WOODEN BOXES MOUNTED ON SMALL TRUCKS ARE EMPLOYED TO CONVEY THE CASTINGS TO AND FROM THE GRINDING ROOM

FIG. 9—THE DIFFERENT CASTINGS ARE SORTED AND PILED IN INDIVIDUAL BINS PREPARATORY TO SHIPMENT FIG. 10—THE SAND STORAGE IS DIVIDED INTO A NUMBER OF BINS BY SEVERAL CONCRETE WALLS

ladle set into an open coke fire in a salamander. The actual molding and pouring is done in the foundry, but the patterns are finished in a building located down the street several hundred yards from the remainder of the plant. This building, erected and equipped for doing light machine work, has one section set apart as a pattern shop for the construction of both wood and metal patterns and pattern accessories, match plates, follow boards, etc.

Melting Practice

A cupola lined to 48 inches made by the Whiting Corp., Harvey, Ill., is employed for melting the iron. The tilting spout shown in Fig. 1 renders it possible to run an almost continuous stream from the spout. A number of 1000-pound ladles hang suspended from the monorail as shown and after one has been filled from one lip of the tilting spout the succeeding ladle is shoved under the second lip. A long handle, clearly visible on each side of the spout, forms a convenient method of tilting the spout from one side to the other.

To prevent the ladles from tipping while in transit between the cupola and the molds, a safety catch has been attached to one side of the bail on each ladle. This catch is shown closed at *BB* in Fig. 1 and open at *B* in Fig. 6. A light rod attachd to the catch and extending to the center of the forked handle of the bail places the catch immediately under the control of the man pouring the ladle.

The coke bed in the cupola weighs 1450 pounds and succeeding charges of iron and coke weigh 2500 and 250 pounds respectively. The iron charges are made up on small 4-wheel trucks which run on a narrow gage track extending from the limits of the stock yard to a turn table leading onto the cupola elevator. The track passes over a Fairbanks track scale and any necessary adjustments in the contents of the trucks are made at this point. A 2½-ton elevator supplied by the Whiting Corp., and operated by compressed air serves to convey the charges from the ground floor to the charging platform. On reaching the charging floor, the trucks are arranged in the order in which the contents are to go into the cupola. A depressed track with a transfer car is employed to shunt the trucks around so that the materials for the first part of the heat are disposed close to the cupola charging door. It will be noted from the foregoing that the iron only is handled twice, once when it is placed on the truck and again when it is taken directly from the truck and thrown into the cupola. As the trucks are emptied they are pushed to one side and loaded trucks brought close to the cupola charging door. A small motor and hoisting drum located in a walled-off portion on the floor of the cupola room operate a cable running over a sheave on a derrick in the yard used for breaking scrap.

The Cleaning Room

After the castings have been poured and shaken out they are loaded into pans similar to the one shown in Fig. 5 and conveyed to the cleaning room on a monorail which enters the cleaning room at one side near the end and extends across to the opposite side.

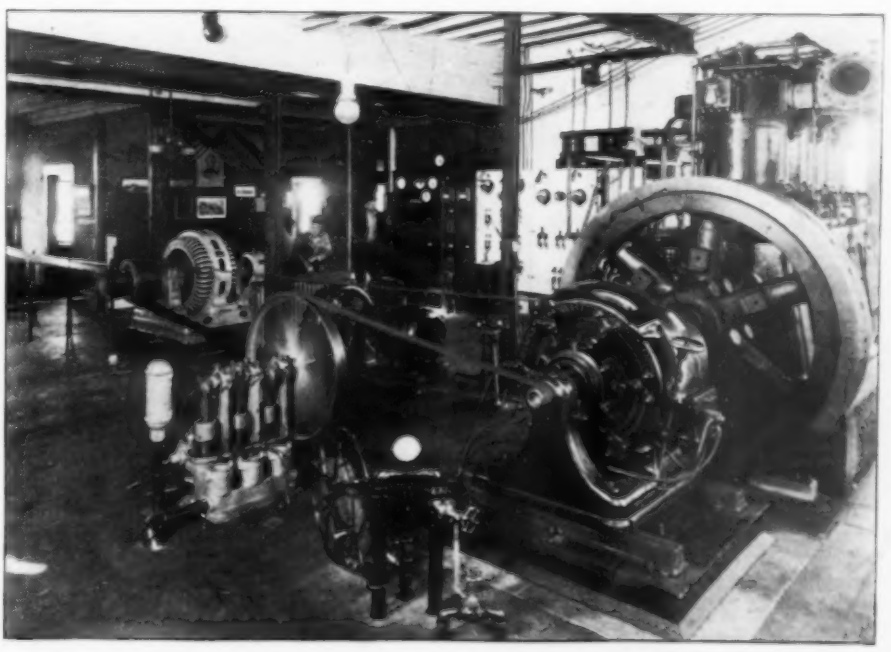


FIG. 11—THE POWER HOUSE ALSO SERVES AS A DISTRIBUTING STATION FOR THE ELECTRICAL NEEDS OF THE TOWN

Branches from this monorail, running at right angles, extend the full length of the room and facilitate the delivery of the castings directly from the pans into any of the tumbling barrels.

The cleaning room equipment, exhaust system, etc., were supplied by the W. W. Sly Co., Cleveland, and comprise among other things three batteries of tumbling barrels with four barrels to a battery and two extra large barrels operated as units. Each battery is driven by a 10-horsepower Westinghouse motor located on the beams immediately above it. A starting box similar to the one shown attached to the wall at the extreme end of the cleaning room in Fig. 7, is employed for starting and stopping each battery. A small chain hoist on each brach of the monorail is used for lifting the pans full of castings. It also is employed for lifting the door of the mill and in the case of the larger barrels, the hoist is used for lifting the castings into and out of the barrel. An iron rod provided with a hook at the lower end, one of which is shown at *H*, Fig. 7, serves to hold the door of the tumbling barrel out of the way while the barrel is being loaded and unloaded.

From the cleaning room the castings are taken to the adjoining grinding and sorting room, Fig. 8, in a number of wooden boxes mounted on small 3-wheel trucks, a few of which are shown in the same illustration. The castings are made so accurately that after they have passed through the tumbling barrels there remain few imperfections to be removed on the grinding wheels. Two small double stand wheels made by the Norton Co., Worcester, Mass., have been found sufficient to take care of the entire output. Each wheel stand is provided with its own motor and exhaust fan.

The custom prevalent in most of the light work shops is observed in the methods employed in grinding and sorting the castings. The operator starts with two boxes, one full of castings and the other empty. He lifts the castings, one at a time, grinds it and drops it into the empty box and by the time he finishes the first box is empty and the second one is full. A second full box then is brought up and the sequence repeated. From the grinding stands the boxes of castings are wheeled onto a floor scale made by the Kron Scale Co., New York, and from there into the stock room shown in Fig. 9. Here they are sorted, packed and shipped with the exception of those that are taken into an adjoining room and painted.

Coat the Castings

Several large vats of black shellac varnish occupy part of the floor space. The castings are strung on wires, dipped in the varnish and after draining for a while they are placed in one of several ovens supplied by the Oven Equipment & Mfg. Co., New Haven, Conn. The oven temperature gradually is raised to 350 degrees Fahr., after which the heat is shut off and the oven allowed to cool. When the castings are cool enough to handle they are removed from the ovens and either placed in stock or packed and shipped.

A view of the interior of the power house is shown in Fig. 11. The gas engine at the extreme right is not used at the present time. It has been superseded by a Westinghouse synchronous motor generator set. Electric current is furnished by the Ohio Light & Power Co., which operates service stations in four neighborhood cities within a radius of 100 miles. This power house in addition to serving the Fate-Root-Heath plant also serves as a distributing center for light, heat and power for the town of Plymouth. The current comes in over heavy duty wires at 13,000 volts and is stepped down in two sets of transformers located in a room back of the switch boards shown in the illustration. One set of transformers in which the current is stepped down to 2200 volts is for the town service. In the second set, the current is stepped down to 440 volts for use in the plant.

In addition to the equipment shown, the power house also contains two air compressors made by the Curtis Pneumatic Machine Co., St. Louis, one driven by a 30 and the other by a 15-horsepower motor. A 35-horsepower gas engine is held in reserve, so that if anything goes wrong with the motor-generator responsible for the compressors or the cupola blower the gas engine immediately can be thrown into action.

Incoming and outgoing material is handled on a spur from the Baltimore & Ohio railroad. Pig iron, scrap and coke are unloaded in the yard in the vicinity of the cupola. Molding and core sand is stored in a special building the interior of which is shown in Fig. 10. A bucket unloader places the sand on a belt conveyor which travels from one end of the building to the other. By dropping a stop at any desired point the sand can be deflected to any one of the four bins in the building. A steel pan suspended from the monorail is employed for carrying the sand into the foundry.

Method of Deoxidizing High-Nickel Steel

BY C. B. CALLOMON

HIGH-NICKEL steel castings containing approximately 36.0 per cent nickel, 0.5 per cent carbon, 0.5 per cent manganese and 0.25 per cent silicon, which are sound and homogeneous, readily can be made in either the electric or the open-hearth furnace if handled correctly. The following procedure is outlined in response to the request on page 407 of the May 15 issue of THE FOUNDRY.

If the electric furnace is used, the steel scrap and the nickel should be charged together as there will be no excessive oxidation of the nickel if ordinary precautions are taken. A few shovelfuls of lime should be thrown on top of the charge and after a pool of molten metal has been made, more lime should be added so that a heavy basic lime slag will be formed to cover the metal. A basic furnace, in the writers experience, is more efficient in melting high-nickel steels than is the acid furnace which is the reason that the use of a lime slag is suggested. It has also been found that ordinary shotted nickel, known in the trade as Grade A shot nickel gives good results in the alloy.

It is extremely difficult, if not entirely impossible, to deoxidize the molten charge completely by any of the ordinary methods usually employed. Most certainly the use of aluminum is not warranted nor is it desirable, as its use in high-nickel content alloys causes sluggishness of the molten alloy as well as brittleness and a tendency to cracking. Above all, the use of aluminum in high-nickel alloys does not insure complete deoxidation. On the other hand, no deoxidizer is known which will completely deoxidize a high-nickel alloy directly, without the necessary preliminary steps which are here outlined.

After the alloy has come to the molten condition under the lime slag, a spoon test should be taken. If the test is wild, a large quantity of carbon should be added, irrespective of what must be the finished analysis insofar as carbon is concerned. In the case of the open hearth, the carbon can be

added in pig iron. If the electric furnace is used, the carbon should be added in the form of coke breeze. Carbon should not be added in the form of pig iron in the electric furnace with this particular alloy. This addition of carbon will do more towards deoxidizing the metal than any amount of deoxidizer in the ladle will do.

After the carbon has worked thoroughly through the bath, a matter of twenty minutes or so, another spoon test should be taken, and the carbon determined. Next, reduce the excess of carbon with millscale. Do not use iron ore for this reduction, as it makes the alloy very wild and counteracts the quieting effect aimed at. The reaction between the mill scale and the carbon will be almost quantitative. After sufficient carbon has been reduced from the melt, another spoon test should be taken to determine if the melt is quiet. If it is still wild, the process must be repeated until the spoon test shows the metal to be perfectly quiet. Additions in the ladle should not be depended upon to make the metal quiet.

When the spoon test shows quiet metal add the manganese in the form of pure manganese or as 80 per cent ferromanganese. After bringing the heat to the required pouring temperature add ferrosilicon.

Tap the heat into the ladle and complete the final deoxidation by means of pure magnesium, using a maximum of 3 ounces to each 100 pounds of metal in the ladle. The condition of the melt will determine the exact amount necessary. The magnesium can be purchased in stick form. These sticks must be so manipulated that they can be plunged to the bottom of the ladle when being introduced into the metal. Magnesium is the only deoxidizer which is entirely satisfactory when used with high nickel alloys. Aluminum should be avoided.

The statement that pig iron should not be used to recarbonize high nickel alloys, is based on practical melting experience and observation of several hundred heats on these alloys, some of which contained as high as 85 per cent nickel. A number of reasons can be given. One is the increased cost of pig iron over coke breeze or broken electrodes. This increased cost is quite an item if a large quantity of the material is being made. Another is that the addition of pig iron to a melt of high-nickel alloy slows up the heat considerably, thereby making the time of the heat much longer.

The carbide slag, which should be carried on all high-nickel alloys, is sensitive to furnace reactions and the addition of pig iron to an electric furnace heat on which there is a carbide slag, causes violent boiling and a consequent foaming of the slag. The violence of this action is likely to cause the carbide slage to change back to the black slag which is worthless as a refining medium. Besides this danger, the violent boiling undoubtedly will cause an excessive oxidation of the carbon which it is desired to put into the metal. It is poor furnace practice to allow a carbide slag to turn black, and once having been obtained, every effort should be made to keep the slag in the carbide condition so necessary for efficient refining.

On the other hand, if coke breeze is used to give the carbon required, the coke can be added a few shovelfuls at a time and gently poled through the slag into the melt. In this case no boiling occurs and the melt will readily take up the carbon.

The statement that pig iron could be used in the open hearth is based on the fact that an open-hearth slag is not nearly so sensitive as an electric-furnace slag, and any excessive boiling caused by the addition of the pig iron can be taken care of by the addition of an extra charge of limestone. Besides, the large tonnages of the average open hearth would compensate for the additional expense of using pig iron instead of coke, as the coke would burn away rapidly under the oxidizing atmosphere of the open hearth.

Seeks Sand Information

The American Foundrymen's association recently has prepared and circulated a questionnaire which has for its object securing information on natural and synthetic molding sands. President W. R. Bean, in a letter accompanying the questionnaire urges the value of this investigation and outlines the work which has been done and now is in progress along these lines.

The Foundrymen's association cooperating with the National Researcch Council at present is preparing a complete bibliography on the subject of sand. The program for the complete sand investigation includes:

1. The collection and publication of all published information on the subject of molding sand in this and foreign countries.

2. The study of field operations by a practical technical investigator and the formulation of a report based upon the practices followed in the best foundries of the country.

3. The preparation of all the information obtained and its submission to a committee composed of practical foundrymen and technical experts with the request that this committee formulate suggestions for lines of research which will result in the greatest benefit to the castings industry.

Why Wind Pipe Should Be Set at a Tangent

Question: On page 535 July 1 issue of THE FOUNDRY under the caption Melting Process Involved in 21-Inch Cupola, you advised that the blast pipe should enter the wind box at a tangent. Why do you advise this arrangement in preference to any other?

Answer: The reason we advised such an arrangement of blast pipe and wind box is because it provides a more even distribution of the blast. We were describing a cupola provided with a continuous set of tuyeres and therefore if the wind pipe was attached radially the tuyeres immediately in front of the inlet would receive a greater supply of air than those further around. With the air entering the wind box tangentially its own momentum gives it a whirling motion which carries it around the wind box and feeds it to the tuyeres uniformly.

In certain makes of cupolas where the wind box extends from the bottom plate to a considerable distance above the tuyeres; and in others where the wind box is an independent chamber from which the blast is conveyed to the cupola through a number of individual pendant tuyeres, the usual arrangement is to connect the blast pipe pointing down on the top of the wind box.

Briefly stated, on a small cupola the wind box is only a supply pipe feeding the branches or tuyeres and it is necessary to adopt means that will carry air to the end of the line. On a large cupola the wind box is more of a tank or reservoir and the velocity and direction taken by the entering air current does not make so much difference.

The Allied Machinery Co. of America, 51 Chambers street, New York, has been appointed foreign representative for the Universal Crane Co., Swetland building, Cleveland. The Universal Crane Co. manufactures a portable gasoline or electric locomotive crane.

How To Make Sash Weight Castings

Out of the Many Methods Available Three Have Been Selected for Description and Illustration Showing How These Castings Can Be Produced Rapidly and Economically

BY J. H. ANDERSON

IN A RECENT issue of THE FOUNDRY I noted that some one had asked for information relative to the subject of making sash weights. The inquiry was answered in a satisfactory manner provided the castings were to be made on a small scale. However, if the contemplated production exceeded three or four tons a day the rig suggested in my opinion would be costly and inadequate. I have had many years experience in the production of these castings and now submit the three following rigs for the benefit of any person contemplating their manufacture.

Rig No. 1. This is a hand rammed job and it will be necessary to supply the following equipment. Two sets of patterns similar to that shown in Fig. 1; a gate plate Fig. 3 and a set of flasks Fig. 2. The patterns for the weights are made of lengths of steel tubing cut to a predetermined length and case hardened after they are finished. One end is threaded on the inside to receive and hold the conical end tips. These sharp tips later form the gate through which the metal enters the mold. The other end of the tube is capped and drilled for a suitable screw by which it is attached to an aluminum bar extending across and holding a set of patterns together. The chills shown in Figs. 4 and 5 are employed to form the eyes in the ends of the castings and also if necessary to leave a suitable figure on the casting indicating the number of pounds of iron in the weight.

Plate Forms the Gates

The plate, Fig. 3, which is to serve as a gate or runner may be made of iron, steel, brass or aluminum. It is pierced with several rows of ½-inch holes, every alternate row staggered as shown in the illustration and corresponding with the holes in the end of the flask shown in Fig. 2. It may be provided with hand holes as shown at *A* and *B* or with a couple of eye bolts to facilitate its removal from the sand after the mold has been finished.

The volume of business will determine the number of flasks required. They may be made of iron or wood, but in my opinion iron or steel is the best material for flasks not only for this job but for any job in the foundry. In any event it will be necessary to provide at least one iron or steel end, that will be the end containing the holes shown in Fig. 2.

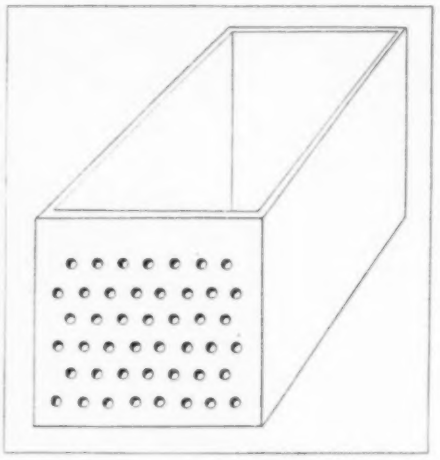


FIG. 2—THE END OF THE ONE-PIECE FLASK IS PROVIDED WITH A NUMBER OF HOLES ARRANGED IN ROWS AND LARGE ENOUGH TO TAKE PATTERNS UP TO 2 INCHES IN DIAMETER

A convenient size for the flask is 24 inches wide, 30 inches deep and 24 inches long for one set. A second set may be made to the same dimensions but 40 inches long. Weights from 8 to 40 pounds, 1½ to 2 inches diameter may be made in these two flasks. The only labor required on this job will be the service of one handy man who easily can be trained in a week, and one boy or girl.

To make one of these molds the molder throws a few shovels of sand on the floor and sets the drag approximately level. He then throws a sufficient quantity of sand in the bottom of the flask so that when it has been tramped down it will be on the level with the bottom of the lowest row of holes in the end plate. The runner plate Fig. 3 then is adjusted vertically and also at the proper distance from the end of the flask. The distance the plate is set from the end determines the length of the sash weight casting. A

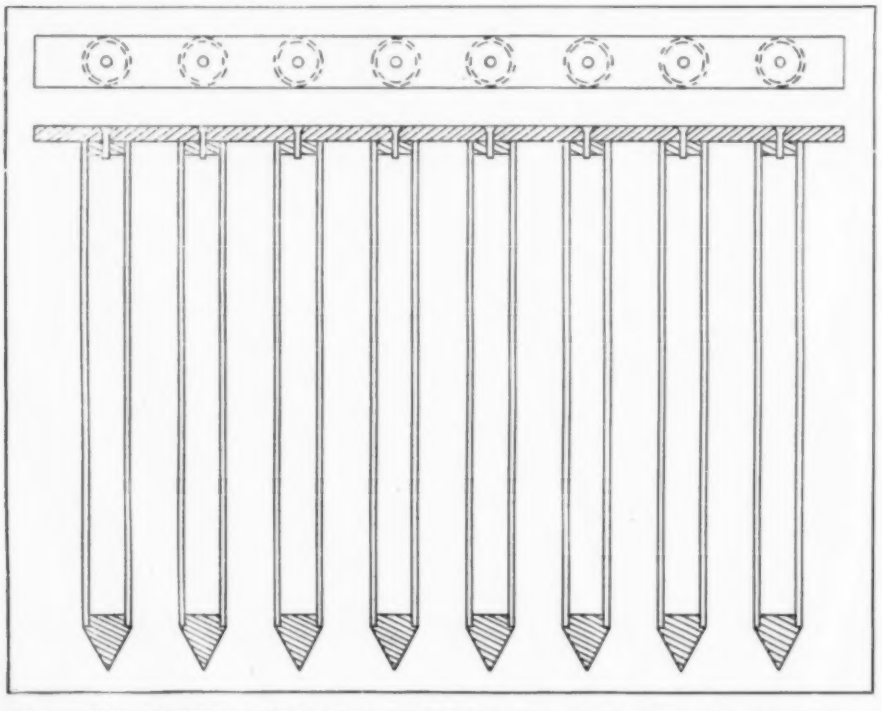


FIG. 1—THE PATTERNS ARE MADE UP OF GROUPS OF HARDENED STEEL PIPES ATTACHED TO ALUMINUM BARS—TWO SUCH GROUPS ARE REQUIRED, ONE WITH EIGHT PATTERNS ON A BAR THE OTHER WITH SEVEN PATTERNS—WITH THIS ARRANGEMENT THE MOLDS WILL BE STAGGERED THEREBY MINIMIZING THE DANGER OF ONE BURSTING IN TO THE OTHER

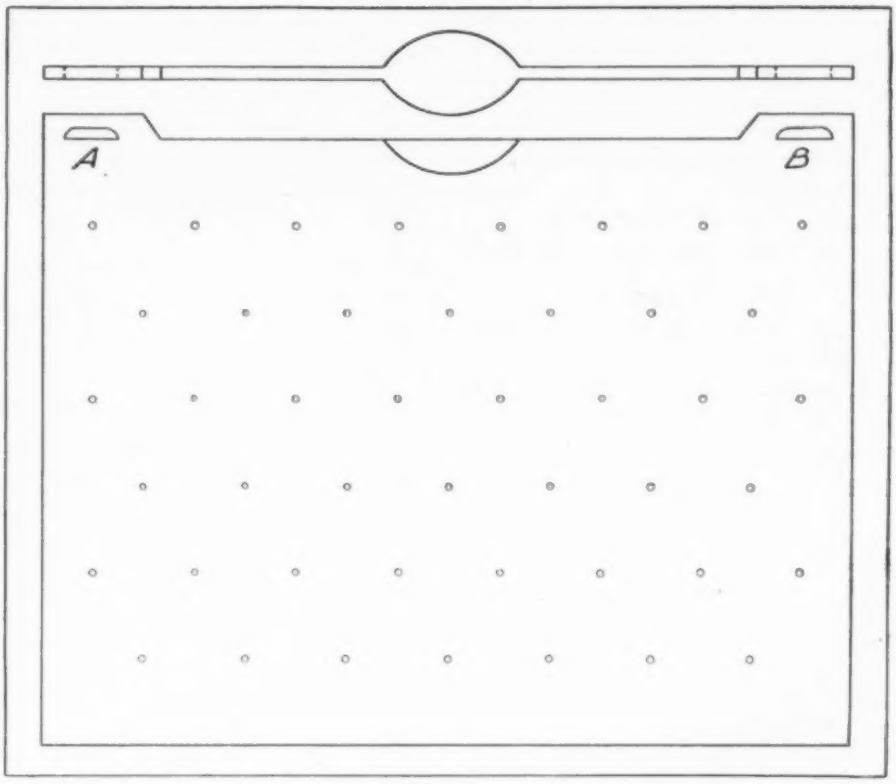


FIG. 3—THE FLAT RUNNER PLATE IS PIERCED WITH A NUMBER OF SMALL HOLES CORRESPONDING WITH THE NUMBER AND POSITION OF THE HOLES IN THE END OF THE FLASK

number of gages should be provided for this purpose.

The bar with the eight patterns attached is now brought forward and the patterns shoved through the end of the flask until the sharp ends rest in the holes in the gate plate Fig. 3. Sand is shoveled in and tucked around the patterns and then tramped off flush with the bottom of the second row of holes in the end of the flask. The second set of patterns with seven on the bar then is shoved through the end of the flask until the tips engage the gate plate. After this set is rammed and the sand adjusted level with the bottom of the third row of holes in the end of the flask the lower row of patterns is drawn out through the end of the flask and returned in the third row of holes.

This sequence of operation is continued with the patterns until the last or top row of holes has been filled. Sand then is filled in, butted lightly and scraped off flush with the top of the flask. A flat weight is set on that will cover the entire surface immediately above that part of the flask containing the mold cavities. The two rows of patterns are then drawn after which the gate plate also is taken out and placed in a second flask where the foregoing procedure is repeated.

While the molder is ramming the second flask his assistant is setting the chills in the end of the first flask. These are the chills, as already has been explained, which form the eyes in the ends of the castings and also serve to close the ends of the holes in the flask. After the chills have been set, the operator daubs the outside with wet sand. An operator easily can gather clean, oil and set chills for several floors. Under ordinary circumstances one of these flasks can be rammed in 15 minutes and when cast the contents will weigh from 200 to 1000 pounds depending on the size of the weights.

This system is not confined to round weights. I often have made square weights from 1½ to 2 inches in cross section. It paid to get up this rig instead of making them from loose patterns in the usual manner. In the illustration the weights are assumed to be 2 inches in diameter. In a large diameter it would be advisable to reduce this number. Otherwise it would be necessary to provide larger flasks and the size outlined is large enough when the lifting is done by hand.

Second Rig Explained

Rig No. 2, is a jolt-ram, stripping plate, molding machine proposition. The necessary equipment comprises a pattern plate to which the patterns are rigidly attached in staggered rows; a stripping plate through which the patterns may be adjusted to any desired height and a set of flasks all the same size but of varying depths to accommodate different lengths of sash weights. A typical set would be made up of 50 flasks, containing 10 of each depth, 12, 16, 20, 24 and 26 inches deep. The cost of such a set should not be excessive as they simply are one piece flasks. Weights from 4 to 30 pounds and from 1¼ to 2 inches in diameter could be made in these flasks by changing the plates on the machine. Chills are employed to close the ends as in the first rig described.

The flask about 2 inches deeper than the patterns, is set on the machine and after the patterns have been adjusted to the proper height sand is shoveled in to a depth of about 8 inches and jolted eight or ten times. The procedure is repeated until the flask has been filled as high as the top of the patterns. The surplus sand then is scraped off and banked around the edge of the flask. These molds are cast open and it is necessary to protect the inside of the flask from the iron.

After the patterns have been stripped through the plate the flask is lifted off and set on its side on a pair of horses. While in this position the chills are inserted in the ends of the openings left by the patterns and then after a

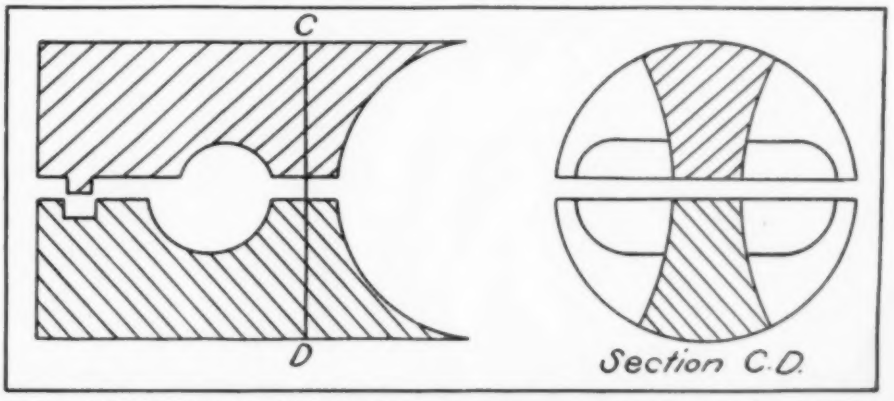


FIG. 4—LONGITUDINAL AND CROSS SECTIONS OF CHILLS USED FOR MAKING THE HOLES FOR THE SASH CORD

bottom plate has been clamped on the flask is rolled back to its original position and set down on the floor. The estimated time for making a mold in this manner is about 8 minutes with two men and each flask will produce from 200 to 1000 pounds of castings depending on the size of the patterns employed.

Using rig No. 3, hinged, water-jacketed chills are employed. These chills usually are set up in batteries two deep and from 12 to 18 in length. They are set up in a pit from 12 to 18 inches deep depending on the length of the chills. A 4-inch water pipe laid on the bottom of the pit connections between the two rows of chills furnishes the water. The 1-inch pipe connections between the back halves of the chills not only serve to convey the water but they also brace the chills and hold them in position. A piece of rubber hose conveys the water to the front half of the chill and allows the front half to be swung away from the back in removing the castings. A suitable drain in the bottom of the pit carries the spent water back to the tank or reservoir from which the supply is derived.

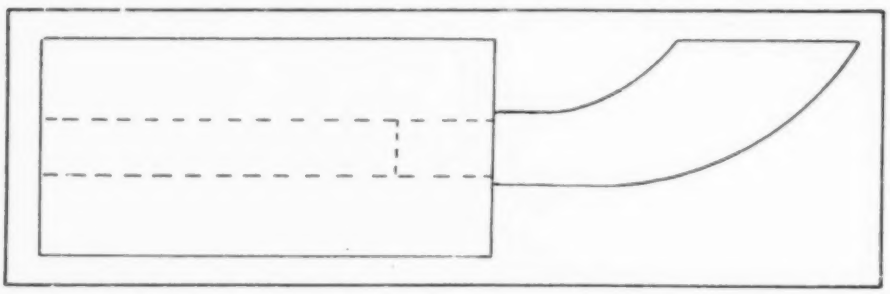


FIG. 5—CHILL USED WHEN THE SASH CORD HOLE COMES THROUGH ONE SIDE AND THE END

Iron can be poured in these chill molds every 10 minutes throughout the day if necessary. By the time the last chill in the battery has been poured the first is ready again. The water prevents them from becoming too hot at any time.

I have no idea how long these molds will last. I have had some of them in use continuously for over five years. Of course reasonable care must be observed to see that they are not abused or burned. The comparatively high initial cost of this rigging has prevented its adoption to any extent, but if the low upkeep cost, low operating cost and other favorable features were given full consideration it would be in use in every foundry where sash weights are made in quantities. Consider no machines, no patterns, no flasks, no sand and no supplies are required and the class of help usually designated as common labor is all that is required to open and close the chills and pour the iron. The halves of the chill are held together by an eccentric clamp which allows the chill to expand as it becomes heated and yet holds the halves close enough together to prevent the iron from leaking through.

Prices of Castings Are Low in Austria

Prices of castings in Austria, when worked out on a basis of dollars, are not as cheap as some recent reports have indicated. As a matter of fact all iron and steel prices in Central Europe are tending toward levels similar to those quoted in other countries, it no longer being possible to obtain extremely low prices as a result of the low rates of exchange.

Austrian foundry pig iron is now quoted at 20,000 crowns ($29.66) per metric ton. Early in June foundries in Vienna and other parts of old Austria were charging the following prices for gray-iron castings: For castings weighing from 2200 to 5500 pounds each, 46,000 Austrian crowns ($66.21) per metric ton, equivalent at current exchange to 3 cents a pound; castings weighing from 11,000 to 22,000 pounds each, 44,000 crowns ($65.25) per metric ton, equivalent to 2.95 cents per pound; castings weighing from 220 to 550 pounds each, 49,000 crowns ($72.66) per metric ton, equivalent to 3.3 cents per pound. A surcharge of 13,000 crowns ($19.27) per metric ton, or 0.875 per pound, is required for complicated castings. A metric ton is 2204.6 pounds.

Book Review

A B C of Iron and Steel, by various authors, fourth edition, 408 pages, 8 x 10¾, cloth, published by the Penton Publishing Co., Cleveland, for sale by THE FOUNDRY, $5 postpaid.

The fourth edition of the *A B C of Iron and Steel* which was originally published in 1915 has been issued in enlarged form because of the persistent and established demand for this very popular work. The new edition incorporates all the important features of its predecessors brought down to date. It includes an exposition of the various processes and forms of manufacture in iron and steel presented in clear finished iron and steel products. These cover the manufacture of rails, tubular goods and tin plate, and are amply illustrated to correspond with the other chapters of the rolling mill section. The new volume contains a revised directory of the iron and steel industry by companies and leading officials. The classification according to products of the various manufacturing companies also has been brought down to date. In this connection the number of open-hearth and electric furnaces and bessemer converters of each steel manufacturer is shown. The very complete statistical data over a period of years on various branches of the iron and steel industry have been brought down to Jan. 1, 1291. Various new illustrations have been inserted in the text.

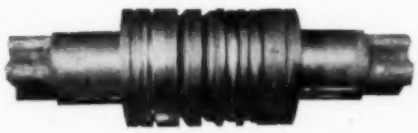
The *A B C of Iron and Steel* is endorsed by the reception it has been given since its earliest edition, from all ranks directly or indirectly interested in iron and steel and is filling an important need in the literature of the industry. Its textbook value and appeal in view of the standing of its various authors as practical men of the industry and because of the simplicity of its style, is very broad. Each edition apparently is finding a wider field of appreciation for the publishers have been called upon constantly to increase the number of copies of each issue.

Build New Plant in South San Francisco

The Metal & Thermit Corp., New York, has constructed and will shortly place in operation in South San Francisco, Cal., a large new plant for the production of detinned billets, in addition to the detinning plants already operated by this company for several years at Chrome, N. J., and East Chicago, Ind. The new South San Francisco plant also has been equipped with a large welding shop containing equipment for and facilities for repairing. This new plant will be in charge of E. Kardos, as superintendent. The former offices of the company located at 329-333 Folsom street, San Francisco, have been moved to the South San Francisco plant.

The Cleveland office of the Sullivan Machinery Co., Chicago, has been removed to 824 Kirby building. Ralph T. Stone is manager.

How Steel Mill Rolls Are Made-I



Metallurgy, Melting and Casting Practice

BY H. E. DILLER

SINCE chemical analyses of metals first were made, great progress has been recorded in metallurgical practice. The chemist and the metallurgist working in the laboratory and at the furnaces in mill and foundry have brought to light many important facts about metals and their proper treatment. Determining the composition of the metal by chemical analysis, the effects of various proportions of the different constituents were found by the aid of testing machines which record the tensile strength, ductility, resistance to shock, hardness and other physical properties. The microscope assisted in the study of miscrostructures, and with the information gained from this source the scientist has built theories to explain the characteristics shown under certain physical treatments and compositions. Much has been learned about the control of iron and steel, and the regulation of foundry practice now is directed largely by chemical analyses and physical tests of the stock and of the product. In addition to these aids, in certain branches of the industry, pyrometry also plays an important role in controlling the pouring temperature as well as in indicating the degree of heat in the annealing and core ovens.

It might seem simple to control foundry operations by the aid of these scientific instruments and methods so that the product is at all times near perfection. True, this is done to a large extent in many branches where the difficulties are not particularly severe, but in the production of certain lines of castings so many complications enter into the process that the causes have not been clearly and definitely traced. In these cases empirical rules have been worked out in the light of past experience and the scientific data is qualified and broadened by these rules. This is the case in the manufacture of rolls where the problems are mainly of a metallurgical nature, the molding process being comparatively simple. The difficulties in the metallurgical side are caused by the large compact mass of metal setting and causing shrinkage strains and segregation. In the case of chilled rolls casting iron against a metal chill it is difficult to secure a perfectly smooth surface on the roll and to chill the metal to a definite depth. In controlling these factors, temperatures of melting and pouring enter into the problem to probably to a

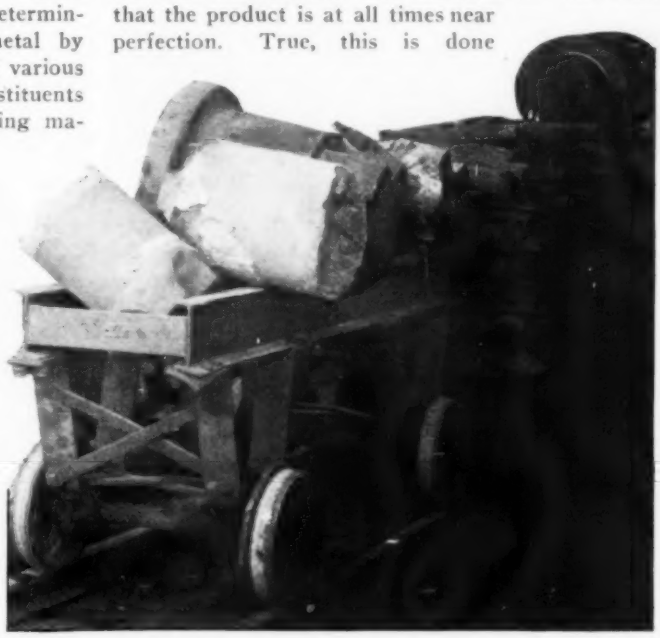


FIG. 2—CHARGE FOR MAKING CHILLED IRON ROLLS—NOTE THE SCRAP ROLLS AND THE SINK HEADS

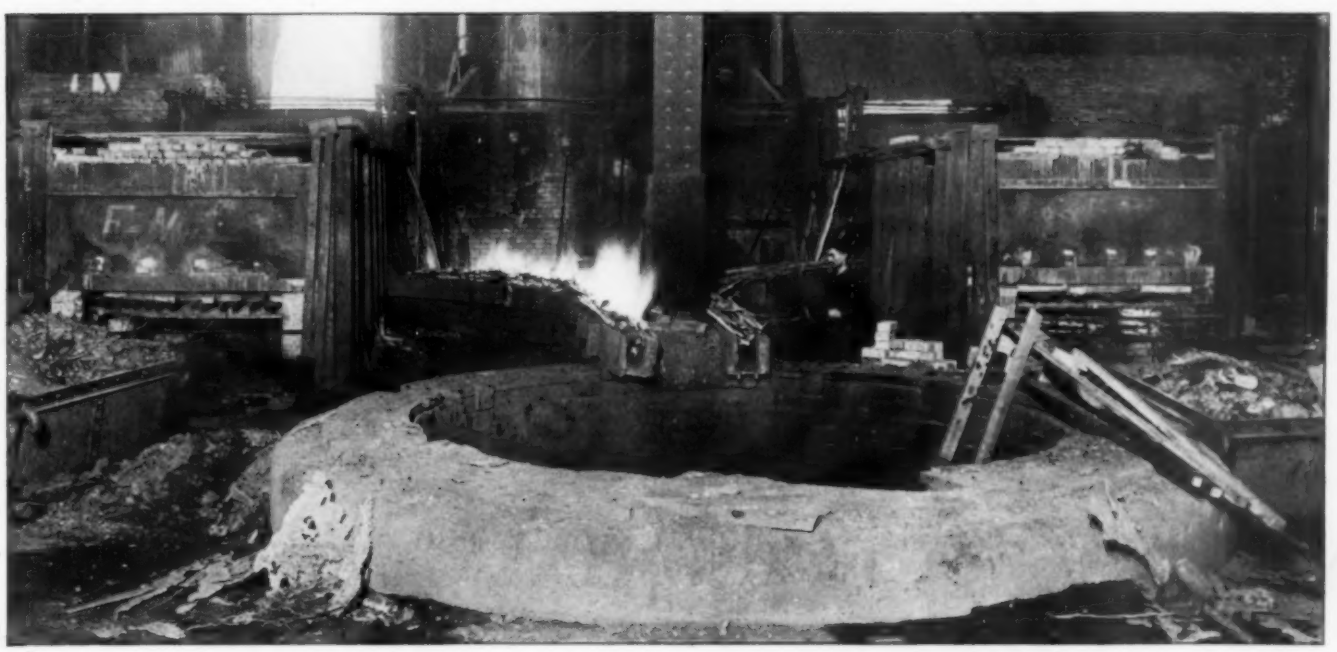


FIG. 1—THESE AIR FURNACES ARE ARRANGED SO THAT BOTH CAN BE TAPPED INTO A LADLE IN THE SAME PIT—THE RUNNER BOXES ARE DRIED BY WOOD FIRES WHICH ARE LIGHTED WITH STEEL BARS HEATED IN THE FURNACE

FIG. 3—THESE AIR FURNACES ARE PLACED END TO END WITH AN INDUSTRIAL TRACK BETWEEN—HEAVY SCRAP IS LIFTED BY THE CHAIN HOIST

greater extent that they do into any other line of castings made. The correct temperatures of furnace operation and for pouring the metal have been worked out on an empirical rather than a scientific basis. The different theories held in regard to the metallurgical side of roll production are discussed in this series of articles as the different steps in roll manufacture are described.

Classified according to the metal in them, three general grades of rolls are made. These are the steel roll, the chilled-iron roll and the sand cast roll. Between the chilled-iron roll and the sand roll is the roll made partly in sand and partly in a chill. The chilled roll is divided into two classifications according to whether it is to be used for hot rolling or for cold rolling.

Steel rolls are made almost exclusively from acid open-hearth metal while the majority of chilled-iron hot rolls are cast from air-furnace iron, and a small percentage of them are produced in the acid open-hearth. Chilled cold-rolls are made from both air-furnace and cupola iron. Reasons for the application of the different melting furnaces used in each case are shown in the detailed description of each class of rolls.

The chilled hot-rolls present the greatest difficulties of any of the iron rolls. One of the essentials distinguishing them from the chilled cold-rolls and the sand-cast rolls is the necessity for comparatively low sulphur content, which is usually kept below 0.08 per cent, but seldom goes below 0.05 per cent. This is one of the factors which precludes the use of the cupola for melting the iron for these rolls, as the danger of picking up an excessive amount of sulphur in contact with the coke in melting is too great. Sulphur in large amounts is objectionable in chilled hot-rolls because of its tendency to cause cracks in the roll when in use.

Manganese is kept between 0.2 and 0.3 per cent. This element in larger percentages tends to produce a sharp line with little mottle between the chilled and the gray sections of the roll. As has been previously noted in the discussion of the manufacture of car wheels manganese also decreases the depth of chill produced on irons which have otherwise identical compositions. In fact the action of the different elements towards the chill are in a general way identical to their action on chilled car wheels. Some carbon is lost in melting and the rollmaker generally tries to produce a chilled hot-roll with from 2.75 to 2.90 per cent carbon. Lowering the carbon to this amount closes the grain of the iron, but does not produce excessive shrinkage which would develop with lower carbon.

The composition of chilled hot-rolls made in this country is quite in contrast with the Swedish practice. The Swedish rollmaker puts as much as 1 per cent manganese in the roll and uses higher total carbon, ranging between 3.25 and 3.50 per cent in the metal. Phosphorus, to the contrary, is kept low, averaging less than 0.05 per cent. This difference in the views of the rollmakers of the two countries indicates a divergence of opinion as to the effects of the different elements on the properties of the roll, or different mill practice, as an American manufacturer would not attempt to use as high manganese or carbon and would not think it possible to cast a roll with less than 0.05 per cent phosphorus.

By melting in the air furnace, the total carbon is reduced and the sulphur content is kept down. The same effects can be obtained from the open-hearth furnace, but to handle the open-hearth economically it must be operated continuously and most roll foundries operate only during day turn. Another objection advanced by rollmakers against the use of the open-hearth furnace is that the metal must never be heated above a certain point

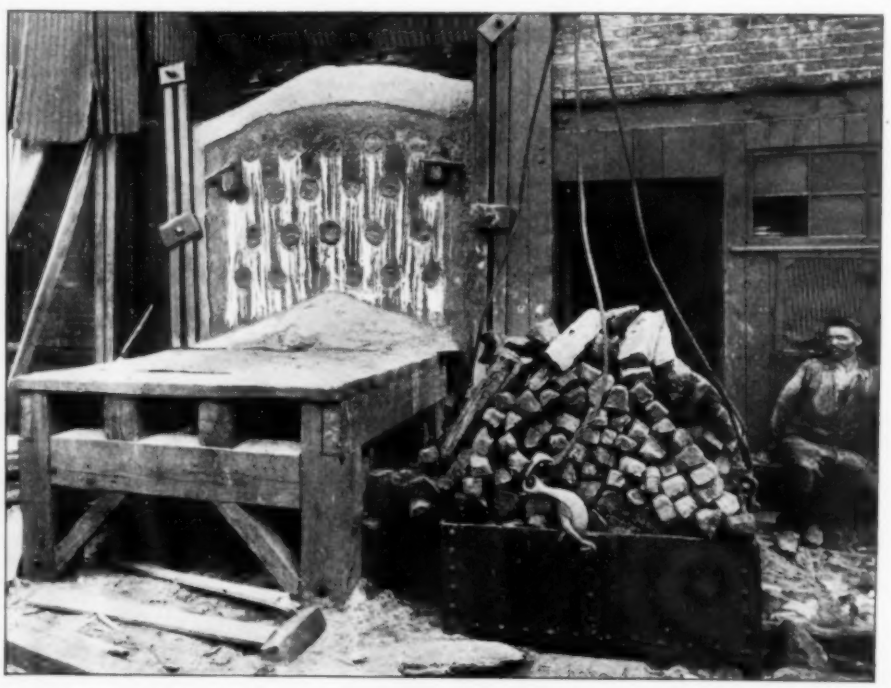


FIG. 4—END VIEW OF ONE OF THE FURNACES SHOWN IN FIG. 1—MATERIAL IS BROUGHT TO IT BY THE CRANE WHICH COVERS THE STOCK YARD

during melting, and the open-hearth offers greater danger of the melter overheating the iron. It has been observed that if the metal is heated in the furnace above a certain point, the characteristics of the metal and its chilling properties gradually are changed.

Stock Does Not Vary

The stock used is the same whether the iron is melted in the open-hearth or in the air furnace. Steel companies which have their own roll foundries return the discarded rolls to be remelted and the independent roll manufacturer usually contracts to buy back a percentage of old rolls. Therefore, scrap rolls form one of the chief ingredients of the mixture. The total amount of scrap, including scrap rolls, heads and runners used in the mixture varies from 40 to 70 per cent of the charge. The largest percentage of the pig iron is warm-blast charcoal. Some cold-blast charcoal pig iron is used, but recently manufacturers have been using a smaller proportion of this grade of iron on account of the high price. Cost also is a factor in inducing some roll-makers to use a small percentage of coke pig iron in the mixture. The importance attached to the pig iron used is illustrated by the fact that one company had a microscopic study made of a new brand of charcoal iron offered to them and would not adopt it on the basis of composition alone.

In addition to the scrap rolls and the pig iron, the heads and gates must be remelted. The extent to which these heads enter into the mixture may be estimated when it is remembered that as high as 20 per cent of the metal poured often is used in the gate and head. Fig. 2 showing a charge loaded on trucks to be taken to the air furnace indicates the character of the mixture. Small rolls are not broken, as indicated by the roll on the rear car.

FIG. 6—THE METALLURGIST WATCHES THE POURING OF THE TEST PIECES TO DETERMINE THE APPROXIMATE TEMPERATURE OF THE METAL

Furnaces are located in the foundry relative to the most economical charging conditions. Many furnaces are built so that one end is flush with the side of the building. In such cases the crane which covers the stock yard carries the metal for the charge to the furnace. Fig. 4 illustrates a furnace so located. The crane carries the pig iron and the smaller scrap to the charging platform in steel boxes, one of which may be seen at the right of the platform. In the illustration, the furnace has been charged and the door which is handled by the crane has been closed and luted with brick and a mixture of sand and fireclay.

Another arrangement of the furnace is indicated in Fig. 3 which shows two furnaces placed end to end. In this case the door is swung on a jib attached to the side as may be noted at the right. The charge is brought from the stock yard by cars on the industrial track laid between the furnaces. Heavy pieces are lifted off the cars by the chain hoist on the traveling I-beam crane between the two furnaces.

After a heat is taken off, the door of the furnace is opened and the slag is cleaned from the bottom. A new bottom is made the next day by spreading a layer of old burned core sand or some similar sand over the entire surface, slanting the bottom towards the tapping hole. Boards about 1-inch thick are laid over the entire bottom to prevent the charge from digging into the sand and forming pockets to hold the metal and prevent it from running out when the furnace is tapped. In this way only one heat a day can be taken from a furnace.

Equipment Controls Charging Method

Various systems of charging the furnace are used. Some furnacemen charge pig iron near the bridge wall which is in the end opposite to the charging door. The heavy scrap is then placed near the door. This facilitates the charging operation. However, when a boom carried by a traveling crane is used for charging the furnace, it is comparatively simple to place the heavy stock in the far end of

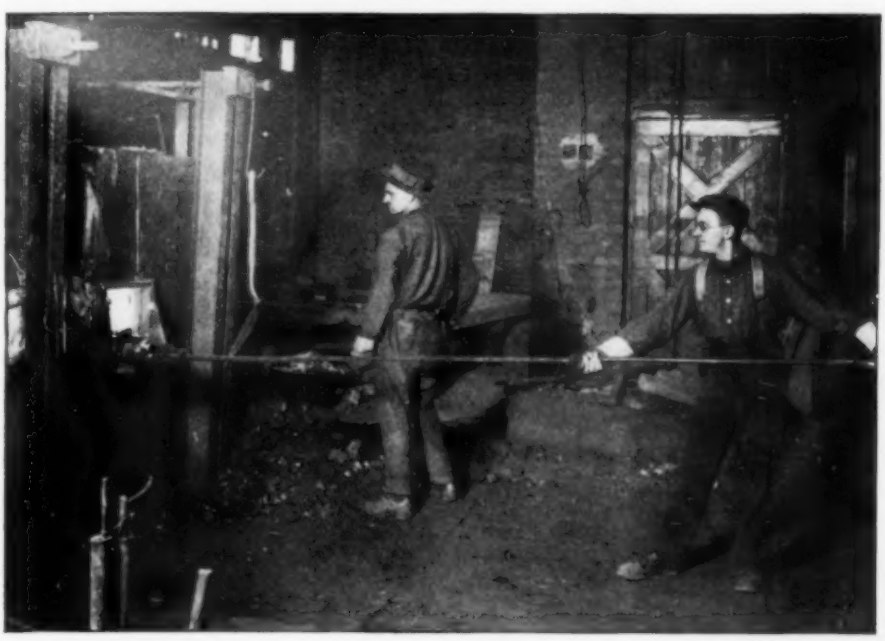


FIG. 5—COAL IS PLACED IN THE FIREBOX ON A SPOON AND CAN BE DISTRIBUTED EVENLY OVER THE GRATE AREA BY THIS METHOD

the furnace. In a few foundries a portion of the pig iron is charged in the base of the stack.

Where the boom is not used, other means must be provided for introducing the heavy scrap into the furnace. One method is to use a set of rollers, such as is shown at A to the left of the track in Fig. 3. This device is placed on heavy planks extending from the car into the furnace, and the roll or heavy riser, placed on top of it, is run into position in the furnace where the charge is pushed off the roller truck. Whatever the relative arrangement of the scrap and pig iron may be, care always is taken to pile the pig iron with the pigs in one layer at right angles to those in the next, and to leave space between the pigs in each layer, thus allowing the flame to penetrate around every pig. Heavy scrap is laid lengthwise of the furnace so that the flame sweeps along its entire length and has a free passage to the stack.

Practically all air furnaces in which iron is melted for rolls are heated with coal. Most of these are hand-fired, although a few are equipped with automatic stokers. Both forced draft and natural draft systems are utilized. One plan adopted with furnaces having natural draft is to have a comparatively low arch on the port leading to the stack. Then, as the bottom of the furnace is continuous with the base of the stack, the metal as it melts flows into the stack and gradually shuts off more and more of the opening between the furnace and the stack, thus decreasing the draft as the furnace heats. Fig. 5 illustrates a method of firing a natural-draft furnace. The melter handles a large spoon on which the fireman shovels the coal. The spoon places the coal evenly over the entire grate.

The metallurgist puts great stress on the melting process and each has his own views as to how fast the iron should be melted. Oxidation in the melting process carefully is avoided by the majority. After the metal is melted, it is thoroughly poled and a test sample is taken. Fig. 6 shows a test being poured. In this case the metallurgist is held responsible for the metal. He tells the melter how to

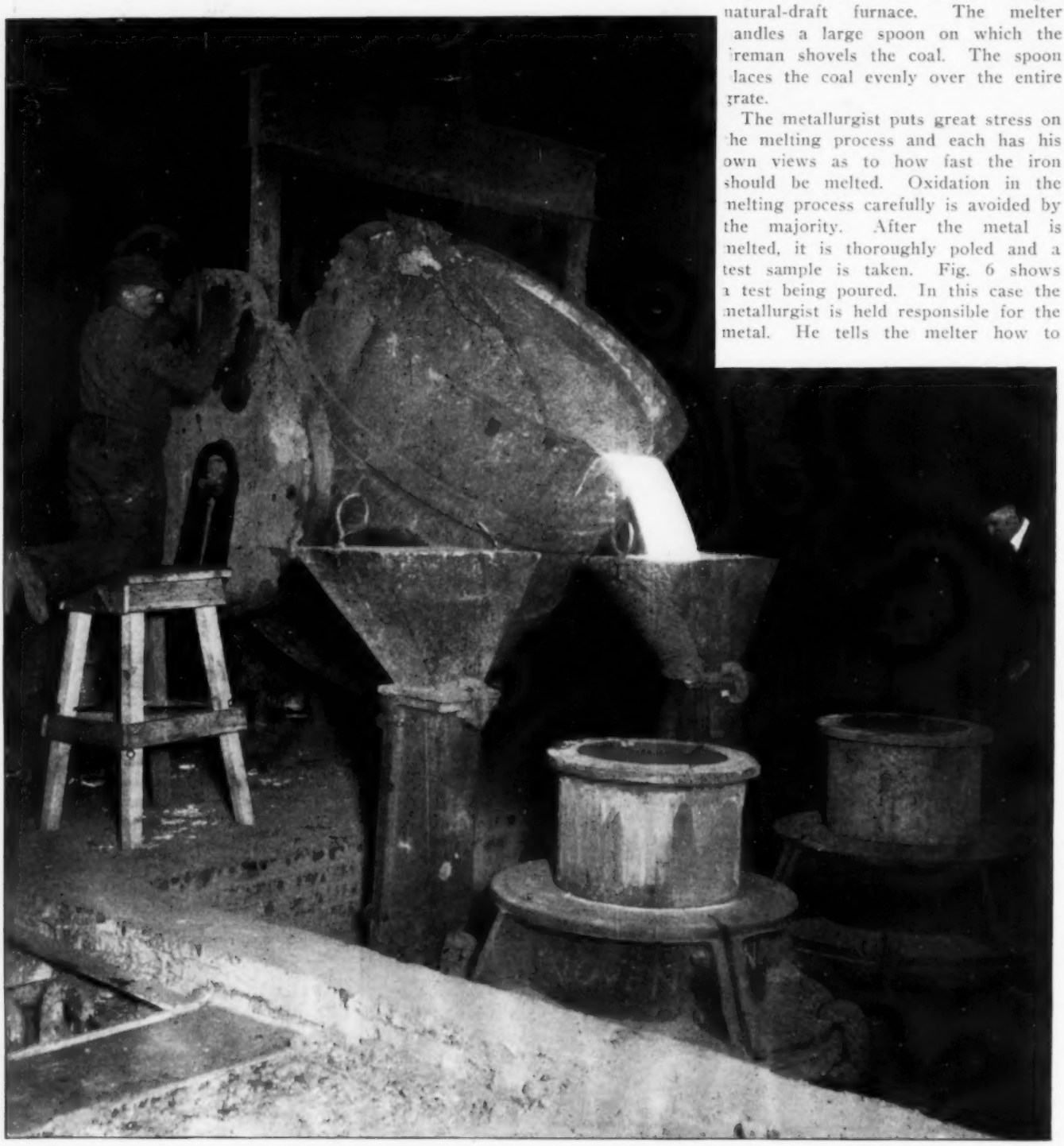


FIG. 7—WHEN THE METAL RISES IN THE MOLD ABOVE THE NECK OF THE ROLL, THE METALLURGIST GIVES THE WORD TO POUR QUICKLY—THE SPEED OF POURING IS CONSIDERED AN ESSENTIAL POINT

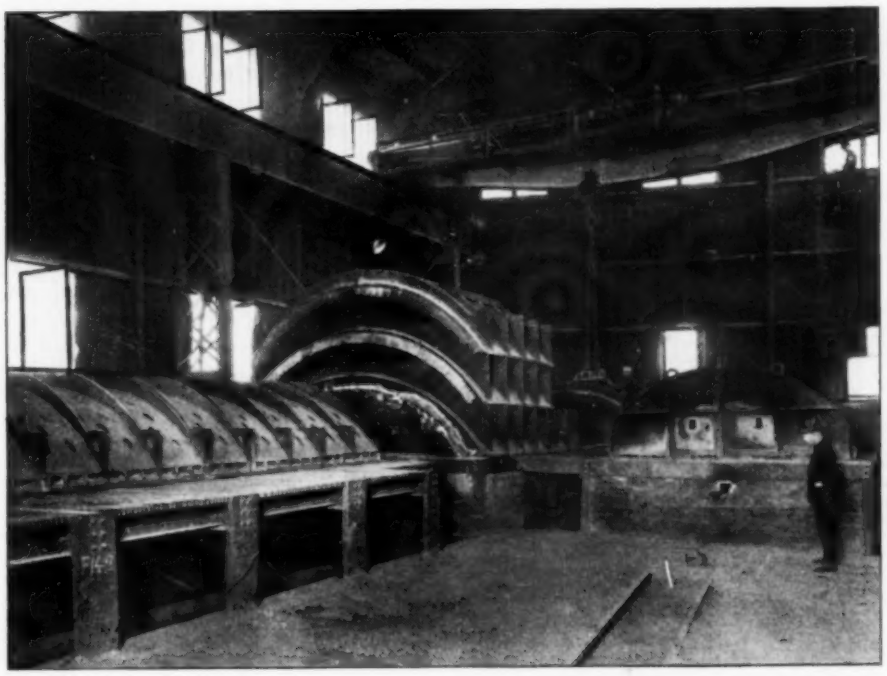


FIG. 8—ANNEALING OVENS IN ROLL FOUNDRIES USUALLY HAVE REMOVABLE TOPS—THE CRANE HANDLES THE ROLLS EXPEDITIOUSLY

treat the iron in the furnace and when to pour.

The test pieces vary only slightly in dimensions at the different foundries. At one foundry a piece is cast in open sand 6½ inches high by 5 inches long and 1¾ inches thick. It has a small notch running vertically across its face in the center. The diagram shown in the insert, Fig. 10, is top view of this piece. The sample is left in the sand to cool a definite length of time, in this case 10 minutes, and then taken out of the sand and allowed to cool to a cherry red in the air after which it is cooled to nearly room temperature by thrusting it in and out of a bath of water. It is then broken across the center where it is marked by the notch. The water cooling is not resorted to until the color indicates that the temperature of the sample is below the critical point.

Controlling the Elements

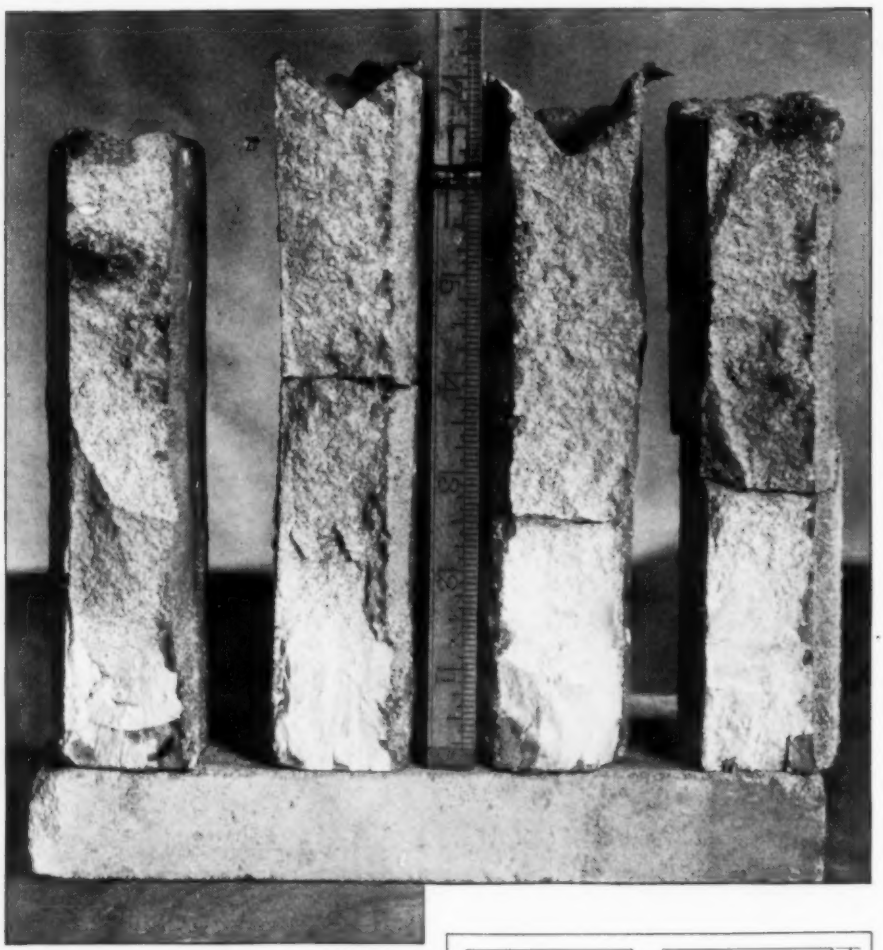
The first test usually shows too light a chill and it is frequently necessary to add ore to the bath to lower the silicon, manganese and carbon. After the ore has stopped working the bath is thoroughly poled and a second sample is taken. This will disclose whether it is necessary to make any more additions. Frequently all that is required is to leave the metal in the furnace a little longer. In addition to the ore, washed metal is often used for the same purpose, either by itself or with the ore. This metal having only traces of manganese and silicon with 3.5 to 4.0 per cent carbon assists to increase the depth of chill in the iron rapidly. Usually four tests are taken before the heat is tapped. At many foundries a part of the first test is sent to the laboratory for the determination of carbon, silicon, manganese and sulphur. These are made in about half an hour after the test piece is drilled which together with the 15 minutes required for cooling and drilling make three quarters of an hour for the test. When the eye indicates the heat is nearly up to temperature, heat tests are made either with a pyrometer or with a rod of low carbon steel or wrought iron which is done quickly. The metallurgist generally employs the pyrometer while the rod test is favored by the melter. This latter test is made by sticking a ½-inch rod in the furnace for a definite time then pulling it out. The rod will be cut by the iron in the furnace and if it is cut sufficiently to bring its end to a sharp point the metal is judged to be hot enough. The pyrometer is more definite in its results and is proving of benefit to the rollmaker. However, the claim is sometimes made that the experienced melter has one advantage over the man who depends entirely on the pyrometer in that he not only can determine the temperature but also judge conditions by the fluidity of the metal. In several foundries the optical pyrometer is used with apparent success and gives check readings by different operators so that the main point necessary to secure accuracy is to be certain that it is at all times correctly calibrated and applied right. Its proper application is essential, as for example in taking a reading of the temperature of the iron in a ladle a false result will be obtained unless the instrument is pointed at almost a right angle to the surface of the iron instead of at an obtuse angle with it.

How the Heat is Governed

The history of one heat is indicated in Fig. 10 which shows the four test pieces taken during the heat. The sample at the left of the illustration was poured at 11:30 a. m. and shows a 1-inch chill. As a 1⅛-inch chill was wanted, 150 pounds of ore was added to the heat. This was allowed to work, and after the batch quieted it was

FIG. 9—THE AIR FURNACE USUALLY IS PLACED ON THE FLOOR LEVEL AND THE METAL IS TAPPED INTO A LADLE IN A PIT

thoroughly poled. Then at 12:15 p. m. a second sample was taken. This showed a 1¼-inch chill, as indicated by the second test from the left, Fig. 10. As this was approximately the depth of chill desired, the bath was again thoroughly poled after a short interval and a third sample, which showed a 1½-inch chill, was taken. Twenty minutes later, after the bath was again poled, a fourth sample, shown to the right, Fig. 10, was poured. This had the desired chill and the heat was tapped at 1:20 p. m. The chill on the roll cast was ¾-inch clear.



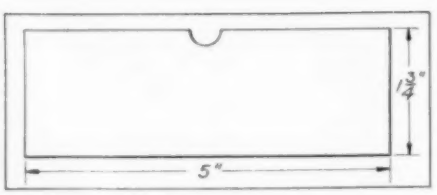


FIG. 10—SAMPLES ARE TAKEN AT INTERVALS DURING THE HEAT—THE ONES ILLUSTRATED SHOW AN INCREASING DEPTH OF CHILL IN THE ORDER IN WHICH THEY WERE TAKEN FROM LEFT TO RIGHT—THE INSERT IS A TOP VIEW INDICATING THE NOTCH CAST IN THE PIECE TO FACILITATE BREAKING IT

In deciding the proper time to pour, not only must the depth of chill and the temperature be considered, but the condition of the mottled surface of the test piece and the way the iron sets on the top of the test piece must be taken into account.

In all, about 2 hours usually are required after the iron is melted, to refine the metal, get the proper depth of chill and the correct pouring temperature. The metal is then tapped into a ladle held in a pit by a crane. Fig. 1 shows an arrangement where two furnaces can be tapped into the same pit. In the illustration, wood is shown placed in the two long runners to dry them. Fig. 9 shows a heat being tapped through a short spout covered with sheet metal. The melter may be noted watching the metal and the metallurgist is shown taking a temperature reading of the running metal.

Usually the metal as it comes from the furnace is too hot to pour and is held a short length of time to cool until the correct temperature is reached, as found by taking pyrometer readings of the surface of the metal in the ladle. Experience has indicated the pouring temperature which gives the best results for each size roll and these temperatures are rigidly adhered to. Temperature readings are taken again as the metal is poured, and kept for record.

The metal is poured slowly until it rises in the mold to within an inch of the fillet of the neck, then it is poured as fast as possible. The time required for pouring the main body of the mold is kept within narrow limits and varies from 20 seconds for the smaller rolls to 60 seconds for the largest rolls. One of the metallurgists is shown at the right in Fig. 7 watching the metal to give the signal to begin rapid pouring.

The metallurgy of chilled rolls for cold rolling is similar to that of the chilled rolls for hot rolling except, as has been said, less care is taken to keep the sulphur content low and therefore some foundries produce these rolls from cupola metal. In this case the total carbon will be higher than in metal from the air furnace, analyzing about 3.5 per cent.

Making Sand Rolls

Sand rolls which, of course, are not chilled, may be made from cupola iron as well as from air-furnace or open-hearth iron. As might be supposed, with greater leeway allowed, a larger variation is found in the composition of these rolls. Sulphur is sometimes found as high as 0.20 per cent and seldom below 0.08 per cent. Phosphorus varies considerably, some roll-makers keeping it below 0.1 per cent while others carry it around 0.5 per cent. Silicon is varied from 0.65 to 1.0 per cent largely depending on the size of the roll, the smaller rolls having the higher percentage of silicon. On the other hand, the manganese content is kept within the same narrow limits as it is for chilled rolls, that is, from 0.2 to 0.3 per cent. However, even here exceptions are made and in some cases the manganese is run higher. The sand-cast roll also differs from the chilled roll in that as much as 10 per cent steel may be used in the mixture. Chromium and nickel also are used as alloys in the iron, being introduced as ferrochrome and metallic nickel or by a pig iron carrying these two metals. More than 1 per cent of either alloy seldom is introduced.

As has been said, steel rolls are practically all made from acid open-hearth steel except for one class which is midway between the steel and the iron roll. This is the roll containing about 1.80 per cent carbon, all of which is held in the combined state. In these rolls silicon, sulphur and manganese are varied within wide limits by different manufacturers, but the phosphorus is uniformly kept low.

The melting operator for the regular steel roll is similar to the standard open-hearth practice. Temperature is considered as important in making steel rolls as it is in the manufacture of chilled rolls. One difference, however, is observed. When the iron roll is poured the temperature can be taken

and if the metal is too hot, check readings can be made, after the slag is removed from the top of the ladle, to determine when the metal is cool enough to pour, but the slag on the ladle interferes with taking check temperature readings after a steel heat has been tapped.

Carbon varies widely in steel rolls which are ordered according to the amount of carbon desired in steps of 0.10 per cent from 0.3 to 1.25 per cent carbon. Silicon usually is kept between 0.25 and 0.30 per cent, and sulphur and phosphorus are maintained below 0.05 per cent. Manganese varies widely in different rolls but generally is held around 0.65 per cent. Steel rolls were formerly made of carbon steel, but of recent years the alloy steel roll is becoming more widely used and many of the roll manufacturers have patented alloy rolls which are said to give superior service to the plain carbon-steel roll.

Alloys Used

Various combinations are used in the alloy rolls. The elements used are nickel and chromium, either together or separately, and high manganese. One alloy is formed of nickel and chromium with high sulphur, the latter running up to 0.2 per cent. Titanium also is used in some rolls. The metal to interest the steel roll manufacturer most recently is molybdenum. This metal is being introduced in some foundries for alloying purposes.

Neither chilled nor sand-cast iron rolls are annealed in ovens, but they are allowed to self-anneal in the mold which is possible due to their great mass. Smaller rolls are allowed to remain in the mold until the morning after they are cast, while the larger rolls stay in the molds a much longer time.

One of the big problems in the steel roll foundry is to get the roll to set quickly. One foundry puts pipe in the mold and as soon as the mold is cast starts water through this system of pipes. As the pipes are placed in the sand parallel to the roll and completely around it, in lines a few inches apart, the roll is cooled uniformly by the flow of water.

Practically all steel rolls are annealed, generally in ovens at the foundry producing them. Occasionally large steel rolls are flask annealed, being allowed to cool in the flask as long as two weeks. One of two types of design of annealing oven generally is used, either the round or the long narrow rectangular oven. In the latter case, which is the one most frequently used, several ovens frequently are built beside each other in a pit and separated only by a thin wall of firebrick. Such ovens are fired from the ends. Another type, as illustrated in Fig. 8, is built half in a pit and half above the floor level. In these ovens, which are fired by oil, the burners are arranged along the sides below the floor line. The method of piling the covering bungs when the oven is opened is shown near the center of the illustration. As may be noted, a crane covers all the ovens and easily can handle the loading and unloading of the rolls.

Annealing ovens are fired with oil, coal or gas, depending on the locality of the foundry and the judgment of the management. Care is used in their design to insure an even heat throughout the oven. Heat usually is applied through ports just above the floor line, but another type of oven admits the heat under the floor which is formed of checkered arches and allows the heat to flow upward from all parts of the bottom. The arches are supported on brick piers which are capped with steel castings to support the rolls which are laid on the castings. The heat entering from one side of the oven passes up through the floor, rises to the roof and passes across and down leaving the oven through flues along the floor line on the opposite side to which it entered. Where the heat is admitted above the floor line, it is usually carried off through flues on the opposite end near the floor. Some ovens have burners and flues on both ends of the furnace, but the burners on one end and the flues at the other end are only used at one time, then by heating from the other end and reversing the flow of the heat occasionally, the two ends are kept at an even temperature. This is controlled by pyrometers with which practically all roll annealing ovens are equipped.

Brass Company Purchases

The Glauber Brass Mfg. Co., Cleveland at present located at 46th. Superior streets, Cleveland, has purchased the plant recently vacated by the National Malleable Castings Co. at Platt Ave. and 79th streets, in that city. Acquiring this plant will permit a marked extension in the manufacturing facilities of the Glauber company. Over 400,000 square feet of floor space in the foundry and machine shops is provided, also a four-story office building.

It is stated that the company will be incorporated and that other brass manufacturing firms will be taken over.

The Glauber Brass Mfg. Co. was started in 1889 by M. H., I. N. and J. H. Glauber. Morris Glauber, the only surviving partner purchased the entire business recently and at present is the sole owner.

Book Review

Gun-Metal and Brass Founding; by H. S. Primrose, M. I. Met., A. I. Mech. Eng., and J. S. Glen Primrose, A. R. T. C., A. I. M. Met.; cloth; 279 pages, 5 x 7; published by the Louis Cassier Co., Ltd., 34 Bedford street, W. C. London, England, and furnished by THE FOUNDRY for $3 net.

The authors are men of practical experience. H. S. Primrose is metallurgist with Hoffman Mfg. Co., Ltd., Chelmsford and formerly was with Carels Freres, Ghent, and G. and J. Weir, Ltd., Glasgow, while J. S. Glen Primrose is metallurgist to Ransomes & Rapier, Ltd., Ipswich and formerly was senior assistant in the metallurgy department of the Royal Technical college, Glasgow. They have endeavored to bring within the compass of this book a sufficiently balanced blending of practice and theory to make it of value alike to the practical worker and to the student of metallurgy who is beginning to specialize in works practice. Much of the subject matter already has appeared serially at a time when unlimited production was asked for, but few were sufficiently equipped with the knowledge and experience required to bring about satisfactory practical results.

The text has been revised and brought up to date sufficiently to incorporate the results of the latest work done in connection with the successful founding of the more prominent alloy known as admiralty gun metal, or perhaps more familiarly as 88-10-2. It also deals with the mass production of brass castings on a commercial basis.

Foundry layout and equipment is described briefly but considerable space has been devoted to the subject of testing material, both as an incoming component and as an outgoing product. The metallographic view point has been kept in its proper place, regard being paid to the importance of the subject and heat treatment is dealt with in a similar manner. The key note from the author's point of view is the undoubted value of complete scientific control of all operations connected with the successful output of alloys.

The list of contents includes: components of gun metal, preparation of gun metal, melting practice, foundry layout and equipment, testing of both raw and finished materials, microscopical examination, heat treatment of gun metal, effects of impurities on gun metal, and handling and melting scrap and dross. In addition three appendices are included, one on foundry cost system, one on chemical methods of analysis and a third on bare wire pyrometry. Twenty-two tables, five foundry forms and numerous illustrations are employed to supplement the information contained in the text.

Studies Failures of Cast-Iron Wheels

Limits Recommended for Composition of the Metal Decided by Analyses of a Large Number of Wheels Which Had Failed—Improvement Needed To Enable Cast Iron To Hold This Field

BY H. J. FORCE

THE general public knows little of the wonderful progress of the chilled-iron wheel industry; nevertheless, it has grown steadily with the railroads and today the commerce of the nation depends upon it. Approximately 26,000,000 chilled-iron wheels are now in use in the United States and Canada, serving under freight cars, passenger coaches, refrigerator cars, engine tenders, city street cars, interurban cars and electric locomotives. From 80 to 90 per cent of all the railroad cars in the United States and Canada are equipped with cast-iron wheels. The annual production in the United States is approximately 3,000,000 wheels, some of which are exported to France, Russia, Italy and other foreign countries. A large proportion of the total production is required for repairs.

It may be asked why chilled-iron car wheels have proved so satisfactory, when other parts of car, track and structure have been superseded by other and more expensive materials. We believe this is due to the character of the metal, for no other material has been able to make any serious inroad on the chilled-iron wheel for the past seventy years.

It is the object of this paper to point out such recommendations and changes as are thought to be necessary in the chilled-iron wheel. It is well known that during the past few years railway cars have been loaded to greater capacity; heavier equipment has been placed on many lines; many roads are using rails much heavier than a few years ago; roadways are rock ballasted, and are largely equipped with tie plates. This rigid track construction has placed a greater duty upon the chilled-iron wheel, a condition which it is felt the manufacturers possibly have not realized, for little or no effort has been made to improve the quality of the wheels to meet these severe conditions.

The cast-iron wheel is about the only part of railway equipment which is not purchased to a chemical specification; yet it is the most important part of such equipment. The failure or breakage of one wheel in a train almost invariably results in derailment. Such chemical specifications as have been recommended are not generally acceptable both to the manufacturer and the consumer. It is generally conceded that unless an improvement is made in the quality of cast-iron wheels, the railway lines will be forced to give careful consideration to the use of steel wheels, with the hope that fewer failures will result in service. From a study of the service condition of cast-iron wheels, we are of the opinion that this wheel can be greatly improved, and that it will be found to be satisfactory under nearly all equipment. It has been claimed that the ordinary wheel on certain lines is satisfactory. This may be true where such lines do not have any lengthy and heavy grades, but where these grades do exist failures from cast-iron wheels are constantly resulting; and as all class of equipment is handled over these lines, it is therefore necessary that the wheels on all lines be made of the best possible composition.

During the year 1920, forty-two failures occurred from broken wheels on the lines of the Lackawanna railroad, and with very few exceptions these were on foreign cars. For 1921, fourteen failures have occurred which caused derailment.

Four wheels were selected from a number of wheels which had been worn out and marked *A*, *B*, *C*, and *D*. Table I shows the date each wheel was cast, and gives the composition. It will be noted that in most cases these wheels meet the requirements of the specifications recommended later, although no effort apparently was made to make the wheels to any specification. The table shows the fact that the composition as to phosphorus and sulphur, and especially silicon, is fairly satisfac-

Table I

Wheels Worn Out in Service

(All values in per cent)

Mark	Cast	Total carbon	Graphitic carbon	Combined carbon	Phosphorus	Sulphur	Manganese	Silicon
A	9-20-15	3.31	2.32	0.99	0.360	0.154	0.49	0.70
B	6- 2-16	3.53	2.77	0.75	0.308	0.136	0.66	0.73
C	7- 2-13	3.17	2.18	0.98	0.304	0.155	0.55	0.65
D	8-24-12	3.08	2.15	0.93	0.260	0.122	0.43	0.59

Table II

Wheels Failed in Service

(All values in per cent)

Mark	Cast	Total carbon	Graphitic carbon	Combined carbon	Phosphorus	Sulphur	Manganese	Silicon
1.....	8-27-17	3.24	2.24	1.01	0.420	0.176	0.57	0.70
2.....	.....	3.36	2.13	1.23	0.430	0.191	0.41	0.82
3.....	.....	3.35	2.46	0.89	0.440	0.200	0.65	1.06
4.....	4-15-18	3.37	1.87	1.50	0.384	0.182	0.39	0.75
5.....	5-28-13	3.34	2.19	1.14	0.388	0.199	0.52	0.75
6.....	3-28-18	3.34	2.10	1.24	0.386	0.146	0.36	0.76
7.....	6-28-20	3.22	1.91	1.31	0.354	0.193	0.52	0.80
8.....	8-21-19	3.20	1.99	1.21	0.384	0.261	0.67	0.88
9.....	3-14-18	3.19	2.24	0.95	0.364	0.171	0.50	0.84
10.....	3- 9-20	3.34	2.15	1.19	0.428	0.185	0.52	0.69
11.....	10-13-17	3.19	2.16	1.03	0.408	0.138	0.38	0.70
12.....	9- 3-19	3.33	2.24	1.08	0.370	0.197	0.60	0.76
13.....	12-30-18	3.32	2.34	0.98	0.420	0.175	0.79	0.73
14.....	.....	3.12	2.14	0.98	0.420	0.219	0.72	0.93
15.....	2-17-15	3.32	2.20	1.12	0.400	0.190	0.43	0.68

Paper presented at the convention of the American Society for Testing Materials, Asbury Park, N. J., June 24. The author is chemist and engineer of tests, Delaware & Lackawana railroad, Scranton, Pa.

tory. It should also be pointed out that the wheels with the lowest sulphur and lowest phosphorus apparently gave the best service. The higher silicon wheels in all cases showed more wear than lower silicon wheels. On the other hand it is believed that the combined carbon content, which in one case is as high as 0.99 per cent, is outside the limit for a cast-iron wheel which would give the best service.

Table II shows a list of wheels which failed in service and in each case caused a serious derailment. Note here the high combined carbon, high phosphorus and uniformly high sulphur, in some cases low manganese, and in many cases high silicon. Wheels of this composition should not, under any circumstances, be placed in service. It will be noted that some of these wheels gave very little service, and we feel quite safe in saying that the wheels described in this table were shipped without the knowledge of the manufacturers as to their chemical composition.

Table III shows our analyses on a number of wheels made on different dates by three wheel foundries, the majority being cast in 1920. Under foundry *B*, which was asked to furnish wheels with not over 0.35 per cent phosphorus, it will be noted there is considerable high phosphorus. This we might say was their first attempt to make wheels to a chemical specification. The same request was made of foundry *A*, and in this case all wheels conform to the specification as to phosphorus. In foundry *N* effort was made to have the wheels contain not over 0.32 per cent phosphorus. It will be noted than in every case the wheels conform closely to the specification, and it is felt that no undue hardship will be imposed upon the wheel makers to have phophorus not over 0.32 per cent, and that a better and safer wheel will in every case be produced.

It is not contended that a chemical requirement will at once eliminate all wheel failures, for it is possible that an occasional wheel will fail in service from inferior composition due possibly to some oversight on the part of a workman in the foundry.

In order to show the necessity for chemical requirements in a specification, we call attention to an analysis of 252 wheels from 28 different foundries that were being removed in our shop in the ordinary routine of operation. No selection whatever was made; the wheels were taken just as they came into the shop to be removed for the various causes cited here.

Cause of removal	No. of wheels	Average life
Brake burns	21	5 yr. 1 mo.
Cracked plates	61	4 " 5 "
Seamy rims	31	6 " 11 "
Worn flanges	56	7 " 8 "
Worn through chill	4	7 " 2 "
Shelled out	33	6 " 6 "
Seamy treads	4	4 " 0 "
Slid flats	35	3 " 4 "
Chipped rims	7	8 " 1 "
Total	252	

Table I

Wheels Worn Out in Service

(All values in per cent)

Foundry	Total carbon	Graphitic carbon	Combined carbon	Phosphorus	Sulphur	Manganese	Silicon
B	3.37	2.58	0.79	0.320	0.157	0.57	0.70
	3.49	2.70	0.79	0.350	0.143	0.53	0.67
	3.30	2.47	0.83	0.320	0.143	0.61	0.69
	3.19	2.56	0.63	0.340	0.157	0.59	0.73
	3.45	2.68	0.77	0.370	0.164	0.54	0.77
	3.35	2.78	0.57	0.350	0.144	0.52	0.72
	3.34	2.83	0.51	0.340	0.142	0.50	0.77
	3.37	2.86	0.51	0.360	0.158	0.48	0.74
A	3.40	2.63	0.77	0.290	0.158	0.54	0.63
	3.16	2.55	0.61	0.350	0.153	0.68	0.64
	3.26	2.53	0.73	0.300	0.142	0.57	0.74
	3.55	2.94	0.61	0.290	0.130	0.59	0.76
	3.37	2.84	0.53	0.270	0.141	0.56	0.69
	3.42	2.94	0.48	0.300	0.148	0.54	0.75
	3.31	2.69	0.62	0.296	0.144	0.52	0.76
N	3.50	2.65	0.85	0.320	0.148	0.52	0.65
	3.47	2.57	0.90	0.330	0.132	0.49	0.71
	3.17	2.41	0.76	0.280	0.141	0.60	0.63
	3.15	2.36	0.79	0.330	0.132	0.59	0.68
	3.29	2.49	0.80	0.320	0.134	0.61	0.66
	3.31	2.56	0.75	0.320	0.130	0.55	0.64
	3.21	2.51	0.70	0.330	0.134	0.58	0.72
	3.29	2.56	0.73	0.292	0.142	0.52	0.70
	3.35	2.60	0.75	0.292	0.125	0.58	0.75
	3.27	2.46	0.81	0.296	0.137	0.60	0.71
	3.29	2.50	0.79	0.286	0.140	0.52	0.72
	3.32	2.55	0.77	0.300	0.126	0.57	0.74
	3.26	2.75	0.51	0.304	0.135	0.53	0.67

The average life of these 252 wheels was 5 years and 5 months. The total percentage of cracked plates in this lot is approximately 24 per cent. Taking this as an average, the total number of wheels removed for cracked plates during a period of 12 months on the Lackawanna railroad would be approximately 8000.

In our judgment, the cracking of plates is due largely to inferior chemical composition. Seamy rims and seamy treads are as a rule due to foundry practice, and are usually the result of metal being poured at too low a temperature. It is hardly necessary to call the attention of the manufacturer to the necessity of immediate improvement in both manufacture and composition of cast-iron wheels.

It is recommended that the question of drop test and thermal test be carefully investigated. We believe these tests should be made as severe as possible, so that none but good wheels may be shipped.

There is every reason to believe that a good, safe, cast-iron wheel can be produced. The drop and thermal tests, together with an examination of the fracture and depth of chill, usually reveal the method of foundry operation. The majority of the failures of wheels previously cited occurred near the bottom of long, heavy grades, probably due to the elevated temperatures which the wheels attained. In nearly all cases failure occurred by rupture of the plate, and it is important, therefore, that the composition be controlled so that as much strength as possible may be obtained and the wheel enabled to withstand the elevated temperatures developed on all heavy grades.

With the increase in weight of the wheel, the heavier plates and thicker flanges, there is good reason to believe that the cast-iron wheel will continue to serve the railways of the United States for many years to come.

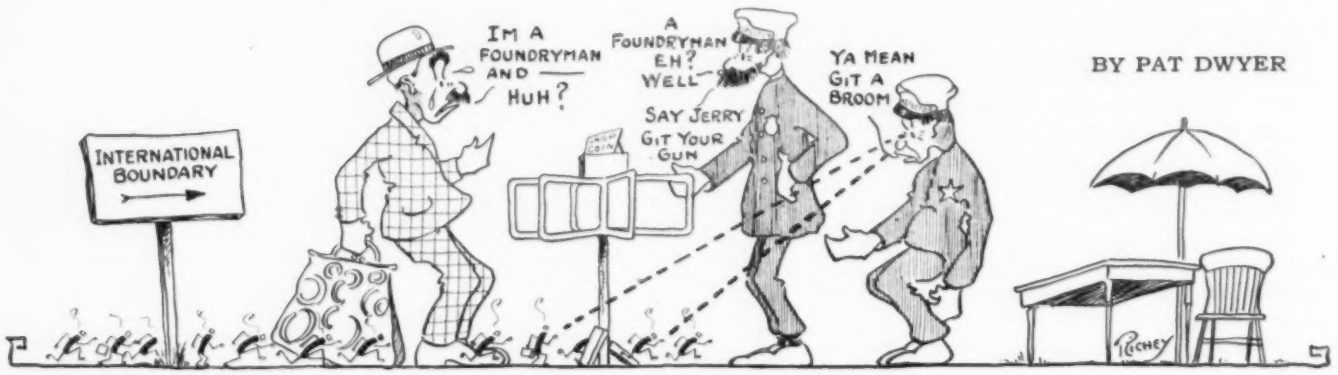
French Foundrymen Again Resume Activities

The Association Technique de Fonderie again has resumed its activities which were suspended during the period of the war. The first meeting of the board of this association was held on Oct. 21, 1920. A recent publication gives the proceedings of this meeting. The association is engaged at present in compiling and publishing information concerning the advancement of the foundry industry during the war.

Although the Pelton Steel Co., Milwaukee, has sold its entire property on Kinnickinnic avenue to the Milwaukee street railway system for additions to car stations, the steel foundry and auxiliary buildings will not be vacated for at least two years, when the transfer is to be completed

Bill Reviews Some Gear Maker's Problems-I

BY PAT DWYER



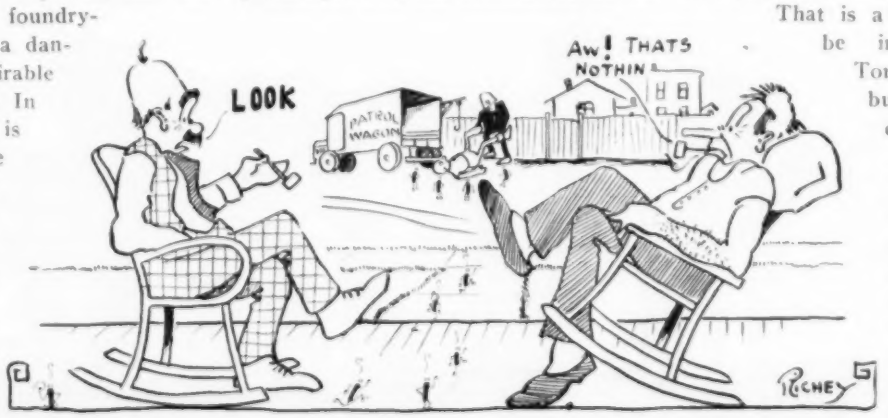
FROM newspaper articles and other reliable sources of information available to the public and others I have gathered that this is a free country with a free press and the right of free speech. With the free press we are not now concerned. It is published in Detroit and at one time was famous through M. Quad's stories of the Lime Kiln club. At present a considerable amount of space is devoted to the doings of the Automobile club and if you are real good you may have one guess on the name of the automobile. Free speech, however, to quote those sterling authorities, Potash and Perlmutter, is something yet altogether different again, Mauriss. It is one of our inalienable rights. When I say *our* I make the statement in a tentative manner. Through a regrettable tactical or technical error on the part of my parents in choosing a dwelling place I cannot qualify as a native.

Having arrived at a time of life when presumably I was competent to choose for myself I came in voluntarily and made application for citizenship papers. It is no secret that the immigration authorities on this side of the line protested my entry vigorously, basing their objection on the fact that I was a foundryman and therefore a dangerous and undesirable type of immigrant. In this connection it is interesting to note that the authorities on the other side of the line raised no objection or filed no formal protest when they found I was about to leave the country. The point I wish to make and eventually will make if my breath and your patience holds out and if some nimble witted gentleman does not beat me to it is that having beat my way into the country, figuratively speaking, in spite of hell and high water,—'scuse me teacher,—it is only reasonable to infer that I intend to stick around for awhile and therefore I have just as much right to say *our* when speaking of a citizen's constitutional rights as if I had been born south of the Great Lakes instead of across the sea.

'Tis not often I enjoy the privilege of indulging in free speech, if you take my meaning, and I am sure those of you who are more or less happily married will experience no difficulty in doing so. However, occasionally I call at Bill's house and unburden myself of opinions on things and events in general. On such an occasion recently we sat on Bill's front porch and discussed almost as many subjects as little Alice's walrus who remarked—if your memory goes back that far—that the time had come to talk of many things, of cabbages, kings and sealing wax and whether pigs had wings.

Among other things I told Bill that recently I had met a prominent foundry manager who had commented on the fact that no boys now are learning the molding trade and he wondered how the business was to be conducted after the present generation of highly skilled machinery molders had passed away. He admitted that in many branches of the business machinery and unskilled help were solving the problem satisfactorily, but in the case of heavy machinery and large engine builders no substitute yet had been found that could take the place of highly skilled mechanics.

For a wonder Bill expressed himself. "When I was a boy," said he, "every big shop had a waiting apprentice list as long as the tail of a kite and look at 'em now. In this city last year approximately 3000 molders were employed and at the same time there were less than 200 apprentices. The molder's trade is being specialized more and more and eventually perhaps everything will be done by machinery operated by unskilled help, but I think that day is in the far distant future and until that time comes there will be need of men skilled in the art and able to turn their hand to any job that may turn up. Consider, for instance, the making of gear wheels and the necessity at times of making several sized wheels off the same pattern. That is a job that could not be intrusted to every Tom, Dick and Harry, but is one that requires the services of a highly skilled mechanic. "I would not think of suggesting that one pattern of a certain diameter be employed for making all the gears required no matter what the face or how many cast-



AN' I SAYS TO THE GAFFER I SAYS "WHO'S MAKING THIS JOB, ME OR YOU?"

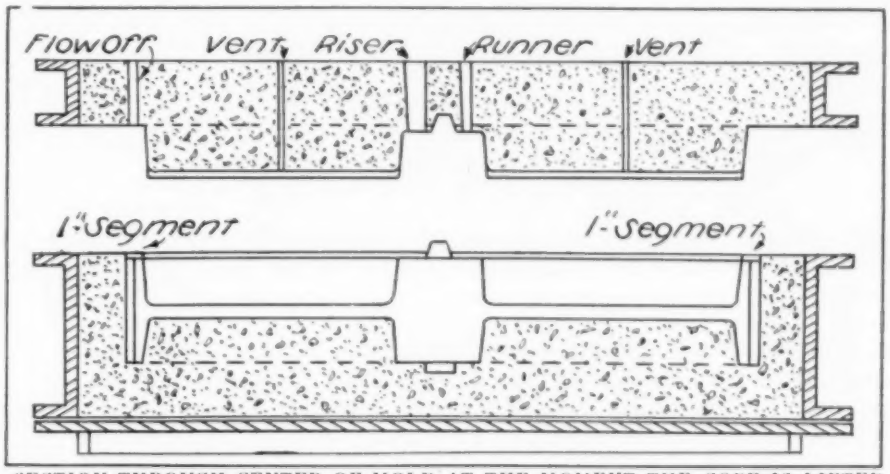
ings are wanted on a given order, but there are occasions when it distinctly is an advantage to adapt a pattern to a size for which it was not designed by the patternmaker. Occasionally a job turns up requiring a gear of a certain diameter and face and the foundryman finds that he has a pattern of the right diameter but the face is either too wide or too narrow. A gear pattern in proportion to its size probably is one of the most expensive patterns to make and therefore if the foundryman can manipulate an existing pattern to meet present requirements it is a distinct advantage to do so.

"Given a pattern with the correct diameter, pitch and number of teeth it is possible to produce many wheels differing widely in appearance. They may be wide faced or narrow, shrouded or plain, individual armed or webbed in the center. Laying generalities to one side we shall consider a few typical cases and trace the operation step by step from the time the molder receives the pattern until the casting is poured. In the first case we shall assume that the customer orders a wheel one inch wider on the face than the pattern which the foundryman has in stock and in the second case we shall assume that the customer needs a wheel one inch narrower on the face than the existing pattern.

"To properly visualize the job let us say that the foundryman receives an order for a gear wheel 6 feet in diameter with a 7-inch face, a 1½-inch pitch and six arms and to be cast with a 4-inch core. He looks over his stock of gear patterns and finds one that meets the specifications in every particular with the exception that the face of the wheel only measures 6 inches and the order calls for a 7-inch face. Two methods are open, depending upon whether the customer insists that the arms remain in the center of the rim or is satisfied to accept a wheel with the arms 1 inch off center. The second method involves much less work on the part of the foundryman and for practically all purposes the resulting casting is just as satisfactory as if the arms were adjusted exactly in the center.

"Following the line of least resistance we shall assume that the customer is a practical man and is satisfied to accept a wheel with the arms a trifle off center. The method of molding the wheel will vary depending on the prevailing shop practice. In some foundries all work of this character is bedded in the floor and in other foundries all the molds are made in flasks and rolled over. Either method will produce satisfactory castings. Personally I prefer to bed medium and large wheels in the floor rather than ram them in drags and roll them over. Unless the bottom board is quite rigid and is rolled over onto a carefully prepared level bed the mold probably will be distorted and will produce a distorted casting. A mold that is made right in the floor will be more apt to retain its shape and produce a casting that is round and accurate in dimensions.

"The molder digs a hole in the floor about 7 feet in diameter and 9 inches deep. Black sand to a depth of 2 inches is shoveled in and tramped off. Straddling the hub with a leg in opposite spaces between the arms he lifts the pattern and sets it down on the prepared bed. It then is rubbed down to a bearing and leveled. Men accustomed to this kind of work can set a pattern approximately level without the aid of an instrument, but the beginner had better try a spirit level on the top of the pattern. If the pattern is not set level it will result in preventing a clean lift when the cope is lifted off and on account of the extra pressure of metal on the lowside of the mold probably will result in a distorted casting. Having satisfied himself that the pattern is resting level, evenly and firmly on the bed, the molder lifts it out and sets it on the floor. He then feels the impression and if necessary presses a little sand into any soft places. A 1-inch thickness of facing sand then is spread over the impression left by the rim of the wheel on the bottom of the hole. The pattern once more is set in and rapped down firmly with a sledge hammer. To prevent damage to the pattern it is customary to hold a block of wood on top of it with one hand and strike it with the sledge hammer held in the other hand. At no time is the block struck heavily. It is moved around the rim of the wheel a few inches at a time and at



SECTION THROUGH CENTER OF MOLD AT THE MOMENT THE COPE IS LIFTED AND BEFORE THE PATTERN HAS BEEN DRAWN A DISTANCE CORRESPONDING TO THE THICKNESS OF THE SEGMENTS RESTING ON THE RIM

ALL THE ROUGH STUFF IS NOT PULLED OFF IN JERSEY CITY

each pause it is struck gently with the hammer. It may be necessary to go around the pattern twice, or to strike one or two points a few times before the molder is satisfied either by intuition or by application of a spirit level that the pattern is level.

"According to one of the old traditions of the foundry it is necessary at this point to place a few pieces of pig iron on the pattern to prevent it from moving. This precaution is entirely unnecessary. In the first place from the very nature of the operation the molder is forced to kneel on the pattern while tucking under the rim and in the second place the teeth and outside part of the mold are rammed first and therefore there is not much chance for the pattern to lift while ramming under hub and arms later.

"If the wheel is to be cast in green sand the facing sand for the teeth should be passed through a No. 8 riddle. In the foundry this usually is known as a sieve, the number 8 referring to the number of meshes to the inch. If the mold is to be skin dried, as many of them are since the introduction of the blow torch as a foundry tool, the sand forming the teeth need not be so fine since the thick coating of black wash applied later insures that the surface of the teeth will be smooth and clean. In either event there is only one proper method for placing the facing sand in the teeth and that is to throw it in one handful at a time.

"The molder fills a riddle with fine facing sand and then with one knee on the edge of the pattern and pushing the riddle ahead of him he goes around the wheel throwing sand into the teeth until they are filled to the top. Black sand then is shoveled in and the 6-inch space between the pattern and the edge of the hole filled and rammed solidly. A 3-inch finishing nail is pressed horizontally in the top of each sand tooth and then a number of wooden segments one inch thick and the same width as the top rim of the wheel are set on and the sand banked up behind them. These segments require no finishing, they are laid off with a pair of trammels and sawed out on the band saw.

"After the sand has been rammed back of the segments the molder might be tempted to make the parting, but it is better to wait until the space under and between the arms has been filled with sand and rammd. The lower edge inside the rim is tucked with a hand rammer and then facing sand is banked against the rim and around the hub. Black sand is shoveled in and rammed after which facing sand is tucked under the arms and enough black sand shoveled in so that when it is rammed it will come slightly above the center line of the arms. The arms on these wheels usually are ellipticle in cross section and therefore the parting line is made along the center line. Having made the parting between the arms a short straight edge is employed to scrape a flat surface flush with the top of the segments resting on the rim of the pattern.

"After the cope has been set on, two runners and a riser are placed on the hub and a flow-off stick set on the rim at a point farthest away from the runners. A thickness of facing sand is riddled on through the bars of the cope and after the necessary gaggers and soldiers have been set the cope is filled with black sand and rammed. In some cases it may be omitted but usually it is advisable to vent the cope. Stakes are driven alongside suitable projections on the side of the cope and then the crane is hitched on, the cope lifted, turned over and set down on its back on a couple of blocks or other support.

In the majority of cases the molder finishes the cope immediately after it has been lifted off, but in the case of a gear wheel this practice usually is reversed. The drag is finished first. This is due partly to the fact that the molder desires to lift the pattern out of the sand as soon as possible. The longer the pattern remains in the sand, especially if the hole happens to be hot, or even warm, the greater the danger of the sand sticking to the pattern. Another reason is that in case the job is late and a second man is sent to help get the mold ready for the iron, he can be sent to finish the cope. Shop ethics demand that when two men work on a job the leading man shall finish the drag and it is surprising how touchy some men are on this point. A third reason, one that automatically arises if the mold is to be skin dried, is that after the drag has been skin dried it can be left to cool as the molder finishes the cope.

"Before drawing the pattern a bent vent wire is employed to vent under the arms. The vents are driven from a channel scored on the joint between the arms. A ¼ or even a ½-inch rod is shoved through the cope at six points corresponding with the center of the vent channels in the drag. If the mold is to be poured green it is advisable to run a row of perpendicular vents back of the teeth, but if the mold is to dried this precaution may be omitted.

"The segments on top of the teeth are removed and after three clamps or three pieces of boards with weights on top are set so that the corners will engage three of the teeth at equidistant points on the perimeter and act as guides, the pattern is drawn up about 2 inches. Facing sand is thrown into the gaps on top of the teeth, a second nail laid in each one and then the sand is slicked to correspond with the remainder of the joint. Usually the pattern will remain in position by itself, but if it should show a disposition to slip a 2-inch block can be placed under each arm to hold the pattern up. The pattern then is drawn out of the sand after which the mold receives the necessary hand tooling.

"If the mold is to be poured green one man shakes blacking out of a bag while a second man follows him around the rim with a bellows and blows the blacking against the faces of the teeth. If the mold is to be dried the wet blacking is applied with a long slender swab and a considerable degree of skill and dexterity are required to avoid knocking the tops off the sand teeth and also to prevent pools of blacking from forming in the lower part of the mold.

"If it is all the same to you Bill" I said, "I move we put away the tools and call it a day. Down in our part of the country a man who put up and skin dried a 6-foot gear wheel mold in a day considered he had done his bit."

"Well," said Bill, "I don't know but what you are right. A few years ago before the name of Mr. Volstead became a loved and honored household word I have known men who claimed they had made 10 and even 12-foot gears in a day. With one foot on the brass rail and one elbow resting on the mahogany down at Tim's place they would dip the end of a horny finger in their beer and draw the most wonderful diagrams which they insisted represented the shape of the flask and the relative position of the ladle and of the runner and riser. The only invariably consistent feature of the stories was the manner in which the castings increased in size as the evening wore away. Starting off with a modest 2-ton casting it was nothing uncommon to find these heroes babbling of 100-ton cylinders by the time the bar tender found it necessary to tap them on the knob with the bung starter and throw them into the alley."

Large Elbow Made in Dry Sand Mold

Interesting Details of Methods Employed in the Production of Pipe Fittings for 96-Inch Diameter Exhaust Line Leading from a 10,000-Kilowatt Installation in a Steel Plant

BY JAMES J. ZIMMERMAN

THE history of the Scott foundry, now the mechanical department of the Reading Iron Co., Reading, Pa. dates back to the early days of the nineteenth century. During that time the foundry has handled a wide line of products. At present, in addition to the various castings required in the company's plants, the product includes all classes of heavy machinery especially those used in connection with rolling mills, sugar mills and cotton packing plants. The foundry building presents no unusual features. It is similar in design and construction to many foundries engaged in the same general line of manufacture.

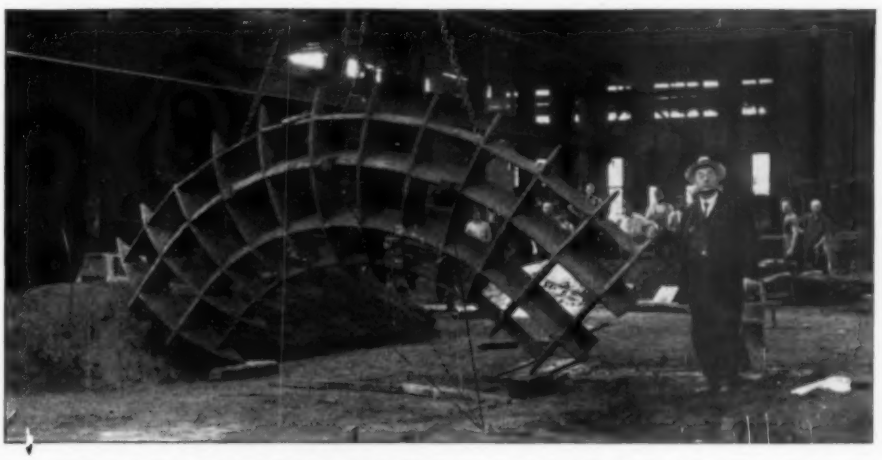


FIG. 2—THE CRAB FOR SUPPORTING THE LOWER HALF OF THE CORE

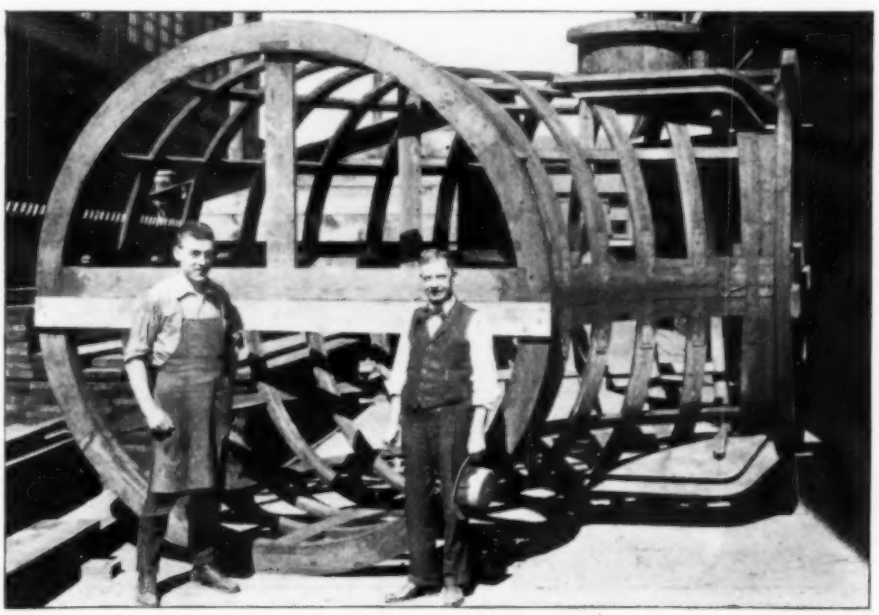


FIG. 1—SKELETON PATTERN PROVIDED WITH TRANSVERSE AND UPRIGHT BRACES

However, it differs to a certain extent in its melting facilities for in addition to two 54-inch cupolas it is equipped with three air furnaces which are employed for melting iron for rolls and special high grade castings that have to conform to severe specifications. Steel is melted in a Tropenas converter and pipe balls are cast from special manganese steel melted in a crucible furnace.

Recently the company furnished a number of large pipe fittings including reducers and elbows for the 96-inch exhaust line leading from the prime mover in a 10,000-kilowatt installation in a steel plant. The elbows, one of which is shown in Fig. 6, were made of cast iron. The walls were 1½ inches thick and the castings weighed 27,600 pounds each in the rough. The flanges were finished 2¼ inches in thickness by 108 inches in diameter. A 24-inch outlet and also two of the suspension lugs are shown close to one end of the casting. The radius on the neutral axis is 94 1-16 inches.

A skeleton pattern shown in Fig. 1 was employed for making both the core and the mold. It will be noted that the drag half of the pattern which is shown in the upper part of the illustration was provided with a number of horizontal and vertical braces which held it in shape until the outside of the mold had been formed.

FIG. 3—SECTION OF A CORE —THE HOLES ARE FOR THE LIFTING HOOKS

The author is assistant superintendent, the Reading Iron Co., Reading, Pa.

The braces then were removed until after the mold had been taken apart and the patterns drawn out of the sand after which they were once more screwed into place to help the pattern to hold its shape until needed again. The suspension lugs and nozzle were made separate and attached to the main pattern by loose pins which were removed after the building of the mold had progressed far enough to hold them in place. The flange around the nozzle was made in segments and attached in the same manner so that it could be drawn in after the main pattern was out of the way. Separate coreboxes were supplied for making the nozzle core and also for the slot cores for the suspension lugs.

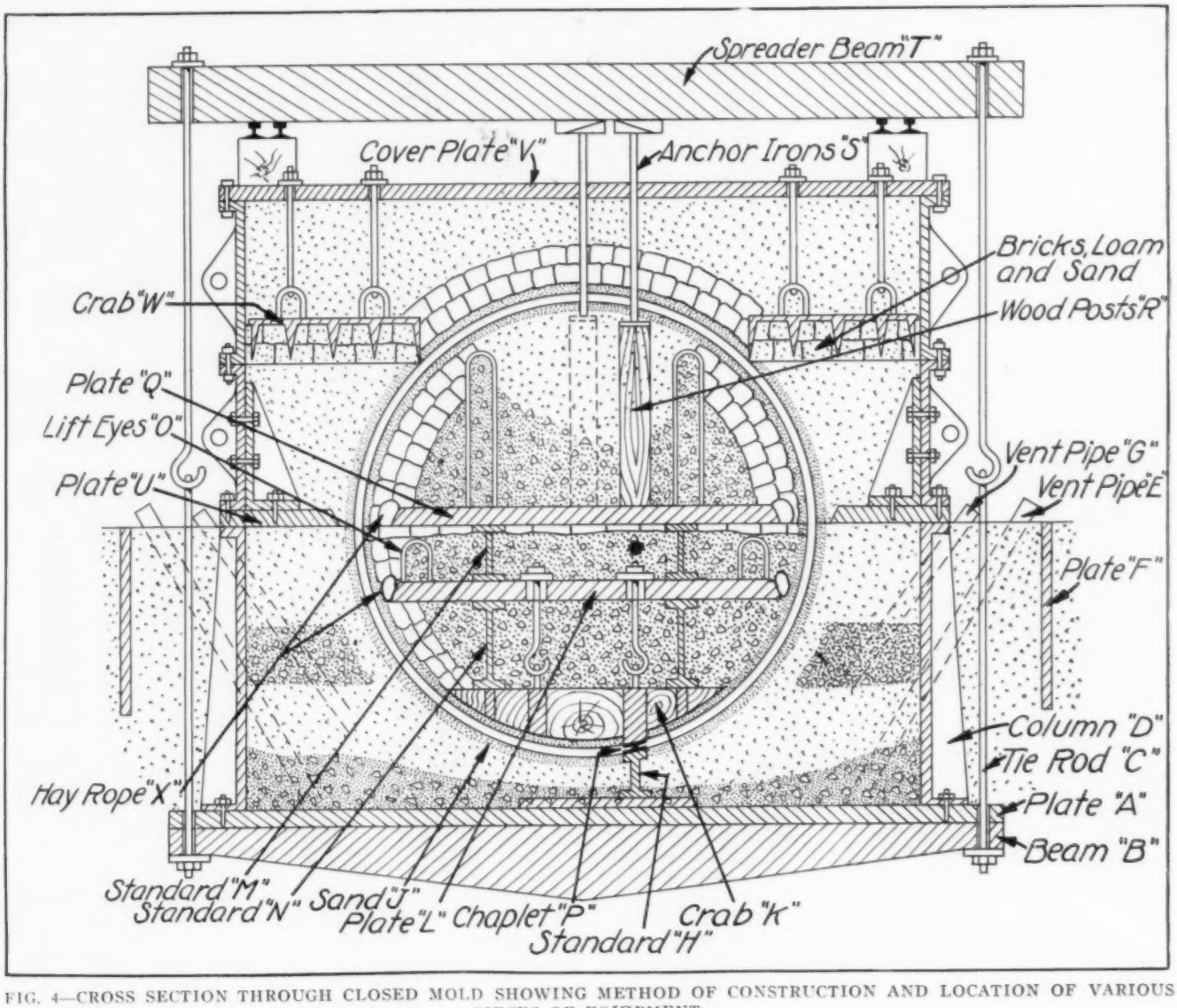


FIG. 4—CROSS SECTION THROUGH CLOSED MOLD SHOWING METHOD OF CONSTRUCTION AND LOCATION OF VARIOUS PIECES OF EQUIPMENT

Building the Mold

The sectional view of the completed mold shown in Fig. 4 also indicates the many appliances and devices used in its construction. Some of the parts form part of the regular shop equipment while many of them, including the crab shown in Fig. 2, had to be made especially for this job. The bottom half of the mold was made in a hole in the floor, but the upper half was made in a cope flask which in turn was made in two parts to facilitate handling.

A hole about 7 feet deep was dug in the floor and on the bottom the six binder beams were set equidistant and approximately level. The 1¾-inch tie rods *C*, Fig. 4, were adjusted in the ends of the beams and then the bottom plate *A*, in two sections, was lowered on to the beams. Next the columns or standards *D* designed for supporting the cope were set in place, one in front of each tie rod, or six on each side. At this time also three standards, *H*, for supporting the chaplets were set 10 inches off the center line as shown at *A*, Fig. 8. Solid bearings, not shown, were built up at each end to support the ends of the arbor.

A heavy bed of cinders was spread all over the bottom plate and provision was made to carry the vent away by setting ten 4-inch vent pipes, three on each side and two at each end of the mold pit. Sand was then rammed up to what approximately would be the bottom of the pattern after which a temporary shoring corresponding in a general way to the shape of the pattern was constructed to serve as a false pattern while the hole was being filled with sand and rammed to the top. At a point about half way up a second cinder bed was placed, provision for carrying away the vent taking the form of ten 3-inch pipes, *G*, Fig. 4, three at each side and two at each end. At this point also the reinforcing plates, *F*, were set in place.

Building the Core

The temporary shoring was removed to make room for the drag half of the pattern which was carefully leveled and adjusted in the proper position in relation to the chaplet and end bearings. Facing sand was tucked and rammed

around the pattern until it was completely covered then the superfluous sand was scraped off flush with the *inside* surface of the pattern. This surface was to serve as a corebox and was extended about 3 feet beyond the ends of the pattern. The core itself actually extends 30 inches beyond each end of the pattern. This was to provide an ample bearing surface so that the core could be bound securely to withstand the lifting pressure of the molten iron.

A layer of paper was laid up against the inside surface of the mold and then the crab, Fig. 2, was lowered into place. It was adjusted so that the three lugs indicated in Fig. 8 came directly over the chaplet standards *H*, Fig. 4. In this way the chaplets came between two metal surfaces and helped to support the heavy core and maintained an even space for the metal which formed the casting. A layer of facing sand

FIG. 6—CASTING ON ITS WAY TO THE MACHINE SHOP

FIG. 5—THE MOLD WAS POURED THROUGH TWO GATES

was spread between the paper and the crab and then the core was built up in the usual manner with brick, loam and cinder. As the building progressed the standards *N* were set on the crab to support the lifting plate *L*. The standards *M* were placed upon this plate in turn to support the lifting plate *Q* on which the top half of the core was built. Vent pipes, not shown, were run from each end of this lower section of the core to the floor line.

The top half of the core was built up by placing the cast-iron plate *Q*, Fig. 4, directly on the lower half of the core and building it up with brick, loam, cinder and facing sand. Long loops cast in the plate and extending within a few inches of the face of the core were provided for lifting this half of the core. A length of hay rope *X* was laid alongside each of lifting plates *Q* and *L* to permit contraction of the casting after it was poured. While building the top half of the core the ten 6-inch square wooden anchor posts *R* were set in the position indicated at *B*, Fig. 8. Four were on the center line of the elbow and the remaining six were on a line 10 inches off center.

Anchoring the Chaplets

The wooden posts were capped with iron plates which supported the anchor irons *S*, Fig. 7. These anchor irons extended through the cope and up to the spreader beams *T*. These beams in turn were attached to the beams in the bottom of the pit by the tie rods *C*. Thus when the rods were tightened the entire

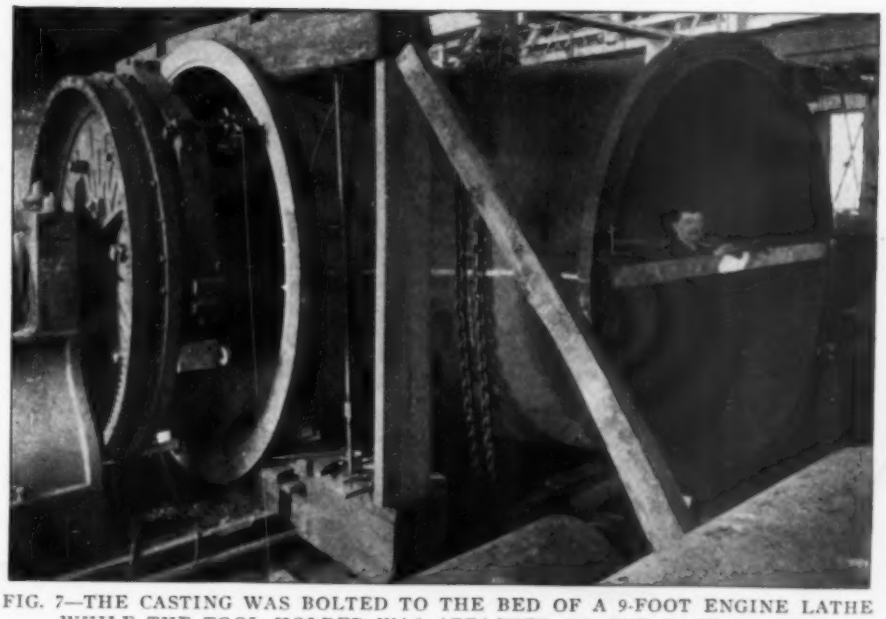


FIG. 7—THE CASTING WAS BOLTED TO THE BED OF A 9-FOOT ENGINE LATHE WHILE THE TOOL HOLDER WAS ATTACHED TO THE FACE PLATE

mold was bound together firmly. Wedges between the top of the anchor iron and the spreader beams were used to take up any inequality in the length of the rods and also to insure the core being held down positively. The anchors prevented the core from swinging upward and acted as a reinforcement to the core prints in keeping the core in its place while the mold was filling with iron.

Wooden anchor posts were used because they charred from the heat of the metal and yielded to the contraction. The contraction on an 8-foot diameter pipe is approximately 1¼ inches and if no provision had been made for contraction the casting would have split. After the upper half of the core had been built to approximately the right size and shape the upper half of the pattern was set on and then with the aid of short sweeps working between the ribs the core was shaped up to conform to the inside diameter of the pattern. The space between the ribs then was filled with sand and swept off to conform to the outside shape of the pattern. This face was covered with paper and the cope rammed against it.

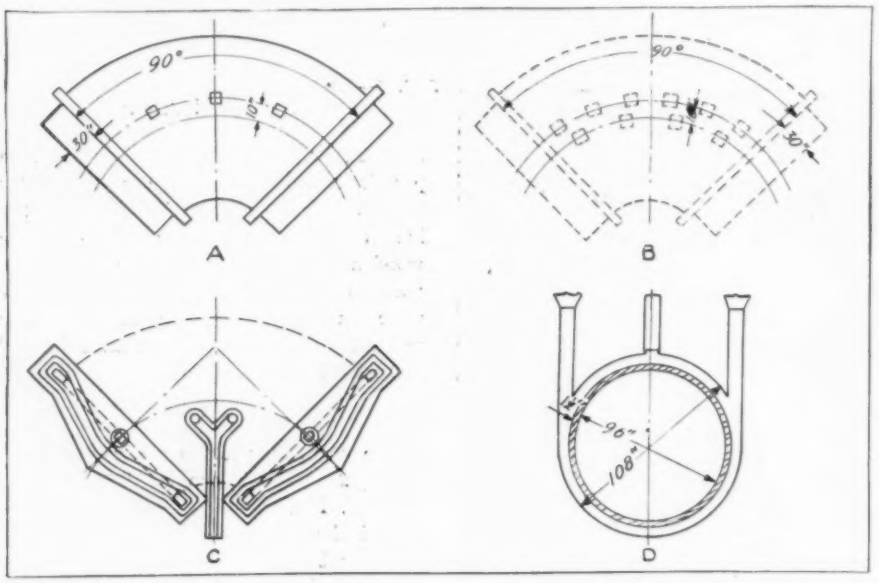


FIG. 8—THE LOCATION OF THE CHAPLETS IN THE BOTTOM HALF OF THE MOLD IS SHOWN AT *A* AND THE LOCATION OF THE VARIOUS CHAPLETS IN THE COPE HALF IS SHOWN AT *B*—THE GENERAL ARRANGEMENT OF THE RUNNERS, RISERS AND FLOWOFF IS SHOWN IN THE VIEW AT *C* AND IN END VIEW AT *D*

The cope which is shown in Fig. 4 resting on a solid iron plate *U* was made in two parts. The sand in the lower half was supported by the plate *U* while the sand in the upper half was carried by the crabs *W* and the brick work as shown in the illustration. The top of the cope was covered by an iron plate in two parts. The parting of the two sections of the cope was made on line where the crabs *W*, Fig. 4 are shown suspended from the top cover plate. After the mold had been built up to the top the cover plate *V*, Fig. 4, was set on and bolted down firmly. The bolts supporting the crabs *W* also were pulled up tight and then the work of disassembling the mold began by lifting off the top half of the cope. This was followed by the second or lower half. They were set up on suitable stands and after being slicked and blackened were run into one of the ovens to be dried. The top half of the core was lifted first and set down and then the lower half of the core was lifted out of the drag half of the mold and also set up on stands where they were finished, blackened and placed in the oven to be dried. The necessary thickness of sand was cut out between the ribs in the drag half of the pattern and the pattern was taken out of the sand. After the bottom of the mold had been finished and blackened it was dried with a number of charcoal fires.

The dried mold was brushed out clean and then the nozzle core and the cores for the suspension lugs were set. The lower half of the main core then was lowered into place until it came to rest on the three chaplets near the center and the core prints at each end. The top section of the main core was set on, followed by the lower and upper portions of the cope in turn. The necessary rigging was assembled on top of the cope and after the binder beams and tie rods had been adjusted and screwed down tight, the risers, runners, pouring basins and flowovers were formed as shown at *C*, Fig. 8. A number of weights were laid on the floor all around close to the joint and sand was rammed between them and the flask to guard against any danger of a runout. Also as an additional safety factor a number of weights were placed on top of the binders on the cope.

The mold was poured simultaneously from both ends as shown in Fig. 5, the metal entering the mold through two upright gates in each flange as indicated at *D*, Fig. 8.

Immediately after the casting had set the weights were removed and as much of the mold as possible was torn down. The sand in the top of the core was dug out to relieve contraction strains. The casting was allowed to remain in the sand for four days and then it was dug out, cleaned and transferred to the machine shop. In Fig. 6 it is shown on the way to the machine shop and in Fig. 7 a similar casting is shown being machined in a 9-foot engine lathe. However, this casting is without nozzle or suspension lugs. The casting is bolted to the bed while the tool is attached to the face plate.

New Die and Casting Plant

The Trenton Chilled Die & Casting Co., Trenton, N. J., recently organized has located in a new plant which is fully equipped for the production of its products. Officers of the company are: President, John H. Conover; treasurer, R. B. Newton and secretary, B. N. Rich.

Purchase Elmira Plant

The Kennedy Valve Mfg. Co., Elmira, N. Y., has purchased the plant of the Ellis Smith Mfg. Co., Elmira, consisting of foundry and machine shop buildings with a total floor space of about 68,000 square feet. The property includes 113 acres of the main line of the Erie railroad, with sidings running into the plant. The Kennedy Valve Mfg. Co., will employ the Ellis Smith plant entirely for malleable iron castings. The plant at present has a total melting capacity of 30 tons daily.

Supply House Organized by Pittsburgh Firm

Application will be made on Aug. 8 by T. E. Malone, formerly of the J. S. McCormick Co., Pittsburgh, George R. McAleenan and John Jackson for a charter of an intended corporation to be known as the T. E. Malone Co. This company is being organized for the manufacture and sale of foundry facings, equipment and supplies.

CHEMICAL ANALYSIS OF PLAIN CARBON STEEL

DETERMINATION OF MANGANESE BY THE BISMUTHATE METHOD

(*Continued from data sheet No.* 390)

Solutions Required

Nitric Acid—Mix 500 cc. of nitric acid, sp. gr. 1.42, and 1500 cc. of distilled water.

Nitric Acid for Washing—Mix 30 cc. of nitric acid, sp. gr. 1.42, and 970 cc. of distilled water.

Stock Sodium Arsenite—To 15 g. of arsenious oxide (As_2O_3) in a 300-cc. Erlenmeyer flask, add 45 g. of sodium carbonate and 150 cc. of distilled water. Heat the flask and contents on a water bath until the arsenious oxide is dissolved, cool the solution and make up to 1000 cc. with distilled water.

Standard Sodium Arsenite—Dilute 300 cc. of stock-sodium-arsenite solution to 1000 cc. with distilled water and titrate against potassium-permanganate solution (about N/10), which has been standardized by using bureau of standards sodium oxalate. Titrate 10-cc. portions of the permanganate solution, to each of which have been added 50-cc. portions of the nitric acid. A clear green color free from brownish or purplish tints will be found a satisfactory and reproducible end-point. Adjust the solution so that 1 cc. is equivalent to 0.10 per cent of manganese, on the basis of a 1-g. sample.

The factor $Na_2C_2O_4 \rightarrow Mn = 0.16397$ (using the 1913 atomic weights).

Method

In a 300-cc. Erlenmeyer flask dissolve 1 g. of steel in 50 cc. of the nitric acid, and boil to expel the oxides of nitrogen. Cool, and add about ½ g. of sodium bismuthate and heat for a few minutes, or until the pink color has disappeared, with or without precipitation of manganese dioxide. Add small portions of ferrous sulfate (or any suitable reducing agent) in sufficient quantity to clear the solution, and boil to expel the oxides of nitrogen. Cool to 15 degrees Centigrade, add an excess of sodium bismuthate and agitate for a few minutes. Add 50 cc. of 3 per cent nitric acid. Titrate immediately with a standard-sodium-arsenite solution to the disappearance of the pink color, each cubic centimeter required representing 0.10 per cent manganese.

Notes

In the method, the preliminary treatment with sodium bismuthate has been found by a number of investigators to be apparently unnecessary; however, the available data to confirm this position are not considered sufficient to warrant its omission.

In making the asbestos filter pad it is advisable to have a thin bed, and as much surface as possible. This insures rapid filtration, and the filter may be used until it becomes clogged with bismuthate.

The filtrate must be perfectly clear, since the least particle of bismuthate carried through the filter will vitiate the results.

(*Continued on data sheet No.* 392)

CHEMICAL ANALYSIS OF PLAIN CARBON STEEL

DETERMINATION OF MANGANESE BY THE PERSULPHATE METHOD

(*Continued from data sheet No.* 391)

Solutions Required

Nitric Acid—Mix 1000 cc. of nitric acid, sp. gr. 1.42, and 1200 cc. of distilled water.

Silver Nitrate—Dissolve 1.33 g. of silver nitrate in 1000 cc. of distilled water.

Stock Sodium Arsenite—To 15 g. of arsenious oxide (As_2O_3) in a 300-cc. Erlenmeyer flask, add 45 g. of sodium carbonate and 150 cc. of distilled water. Heat the flask and contents on a water bath until the arsenious oxide is dissolved, cool the solution and make up to 1000 cc. with distilled water.

Standard Sodium Arsenite—Dilute a sufficient quantity of stock-sodium-arsenite solution with distilled water, and standardize against a steel of known manganese content, as determined by the bismuthate method. This solution should be of such strength that each cubic centimeter will be equivalent to 0.10 per cent of manganese on the basis of the weight of sample taken.

Method

In a small Erlenmeyer flask or large test tube, dissolve 0.1 to 0.3 g. of steel, depending on the manganese content of the sample, in 15 cc. of the nitric acid. Boil gently until the solution is complete and the liquid is clear. Add 15 cc. silver-nitrate solution and 1 g. of ammonium persulfate, and continue heating the solution for ½ minute after the oxidation begins and bubbles rise freely. Cool in running water and complete the determination by either of the following procedures:

Colorimetric—Compare the color of the solution with that of a standard steel treated under like conditions.

Titration—Titrate with standard-sodium-arsenite solution to the disappearance of the pink color, each cubic centimeter required representing 0.10 per cent of manganese.

Notes

In order to obtain reliable results by the colorimetric procedure, the standard should be of the same kind and of approximately the same chemical composition as the sample steel. The manganese content of the standard steel is determined by the bismuthate method.

The ammonium persulfate should be kept in moistened condition by small additions of distilled water at required intervals.

(*Continued on data sheet No.* 393)

THE FOUNDRY DATA SHEET, AUGUST 1, 1921

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

Apply Premium System to Foundries

Fair Dealing to Both the Employer and the Worker Is the Foundation of the Unit System Based on Time Study — Complete Outline of the Plan Is Given

BY HORACE C. BARKER

PREMIUM systems which are not fair to both employer and workmen cannot be operated without friction. However, if a system is installed which is fair to both parties, and is understood to be so, little opposition will be encountered. One of the main defects of some premium systems is that no effort is made to obtain an exact measure of the productivity of labor. The molders not knowing the value of the measure of their efforts have restrained production, while the employers for the same reason have attempted to cut the piece price on the work. A logical method of measuring the effort of individual worker and a plan of remuneration based on the result of this measurement is the first step in establishing co-operative relations between the worker and his employer.

In my opinion, workers in all industries are entitled to a base rate of pay which protects them against delays beyond their control. The foundry industry is no different from others in this respect and a premium system of remuneration, based on accurate determinations of the productive effort required on each piece of work by means of time study, would greatly increase the production, reduce the labor cost per unit of work, and cut overhead costs to a minimum.

In taking time studies, many men have failed to get results because the feelings of the worker under observation were not considered. The object of the study should first be carefully explained to the molder in order to win his approval and co-operation. He should know that the timing is being made for the sole purpose of setting equitable rates on the work being performed that will be fair to him and his employer alike.

It is impossible to step up to a man, pull out a watch, start marking figures on a sheet of paper, and expect the man to co-operate by giving a good, clean study of his motions. Instinctively he becomes sullen and antagonistic and will not work normally. This feeling should not exist in the mind of any man. The worst possible condition is to have a body of workers suspect that they are being timed without their knowledge. No man can actually object to his motions being studied if the observer will present the matter to him in the proper light.

Explain to the worker that proper allowance is to be made for rest and delay and that the time study is the only means of arriving at a measure of the work he performs, so that he may receive the proper measure of money in return. Then the operator will regard the time study as a protection to him and will do all in his power to give a clean and accurate study. Inform him that he must not slow down nor speed up, but simply work along at his normal gait. It is then entirely possible to win the co-operation and confidence of the men and then the time-study man will be respected instead of hated and despised as is the case in some factories where the human element is not considered and the men regarded as part of the machines they operate.

Analysis of the Work

Before taking actual timings of the task or operation, make a careful analysis of the work, its peculiarities and the way it is handled. Then study the pattern and the tools used, and consider the molder. See that the work is in the most effective position for handling by the operator. It is obvious that the work must be in best position if the operator is to cut lost motion to a minimum. Determine if the operator is efficient, mediocre or inefficient, and whether he is working fast, normal or slow. Note these conditions on your sheet. Make your record true to name a *study*.

The next step is to analyze or split up the cycle of the operation into its component parts or elements. The job itself determines if these divisions must be most minute or whether or not it is entirely feasible and satisfactory to group several elements together as a part of the operation.

Clip the sheet on which the timings and data are recorded onto a piece of board large enough to conveniently hold it. Cut a circular depression on the upper right hand corner and hold the stop watch in it by a spring. Leave the stem of the watch project so the left thumb is in the natural position to start and stop the watch. I find this position of the watch and sheet most convenient but other observers prefer the watch held in the center of the top edge. In either case the board is held on the left arm of the observer, the right hand being free to mark down the observations and timings. A watch whose dial is graduated into tenths and hundredths of a minute is the easiest to use for this work.

No Rule Fits

The number of molds that should be timed depends entirely on the rhythm of the operator. If he is working at a satisfactory normal pace, it is evident that only a small number of observations or complete timings will be necessary. The judgment of the time-study man must determine the number of complete molds necessary to time in order to arrive at a correct standard. No hard and fast rules can be laid down.

The watch is not stopped from the time it is started on the first element of the first piece until the last element of the final piece is observed. The *continuous* time is marked against each motion or element on the sheet as the molder accomplishes it, and the individual time for each element is computed when the study is finished.

The timings on individual elements or divisions of the entire operation are carefully compared after they have been computed, and all items, which show a variation of more or less than 25 per cent from the average are eliminated. Such items are generally due to an error in reading the watch or to some condition in the method of handling the work that happened to be out of the ordinary, such as the the dropping of a pattern on the floor by the molder or some similar accident.

Conditions like these are provided for in the rest and delay allowance which is made later, so they are struck out from the time study. Good judgment must be exercised in determining whether or not certain items should be eliminated but the 25 per cent variation rule is a safe one. After calculating the average time on the elements and all excessive variations have been struck out, ascertain the minimum or lowest individual time on like elements and divide this value into the average. The resultant is called the *deviation*.

The individual deviations for each of the detailed elements are calculated and set down in a column. These are then averaged and the quotient is called the *average deviation.*

Operators working in good rhythm should show a deviation between 1.20 and 1.30. In case the deviation is greater than 1.30 the operation should be restudied as the operator evidently was not in good rhythm and it is doubtful as to whether this timing is correct for a normal operator. It is uncommon to get a deviation below 1.20 except on fast cycle work where the operator is expert and in excellent rhythm.

The average deviation is divided into the average of the individual times for each element, thus determining the *selected minimum time.* The total of these selected minimum times gives the *total selected minimum* or *cycle time.*

The next step is to add a certain amount of time for rest and delay to the actual time. This amount cannot be accurately determined from an empirical formula but depends entirely upon the nature of the work, the length of the operation, etc. The time study man must exercise good judgment and add sufficient time for rest and delay so that an average operator working at a normal gait could equal the standard without any undue exertion. This total time in minutes then is the standard for the work and is expressed in units. For example, if it took a man 12 minutes to make a mold and we allowed him 3 minutes for rest and delay, the total time would be 15 minutes or 15 units. The hourly standard is 60 units, therefore, the molder would be required to make 4 molds per hour; 4 x 15 units equaling 60 units. The standard for a day of 8 hours is 8 x 60 units, or 480 units.

These standards which are based on time only do not fluctuate, so they are guaranteed to the men as long as the pattern or method of doing the work is not changed. The standards, which must be accurately set, are fair and represent a good day's work and the molders have no fear of a wage reduction. Base rates of pay are established after an analysis of living conditions has been made or, when necessary, are made equal to the prevailing wage for molders in the community.

When a molder equals standard for the day, he earns his hourly base rate times the number of hours he worked. If he exceeds standard and earns, say 600 units, he is paid a premium on all units in excess of 480, which, in this case is 120. If the molders base rate is $0.60 per hour and the standard is 60 units per hour, each unit has, therefore, a value of $0.01. His premium would be 120 x $0.01 or $1.20. His total wage would be his base rate of $0.60 x 8 or $4.80 plus $1.20 premium or $6.00.

However, we do not give him his entire premium but only 80 per cent of it. The other 20 per cent goes into a pool which is distributed among the superintendents, foremen, laborers and all others who, by their direct efforts, made it possible for the molder to earn this premium. The molders premium in the above case would not be $1.20 but 80 per cent of it, or $0.96.

This method provides an incentive to every productive and nonproductive worker in the foundry, from the superintendent to the lowest paid laborer. It is not a bonus plan. Nothing is given to the men free and for that reason this system meets with the approval of the workmen.

The writer is installing the above system in a large manufacturing institution and finds it is received favorably by the management, the foremen, and the workers. It is adapted to productive effort of all kinds, whether it be a foundry or a watch factory, as it is based on a fundamental law of scientific management, the "Reward of Efficiency." It cannot fail if installed gradually and if care is taken to acquaint the workers with its advantages.

How and Why in Brass Founding

By Charles Vickers

Metal for Pump of Die-Casting Machine

We are having considerable trouble when die-casting aluminum due to the failure of the pump which we are making of cast iron. We are unable to get the right mixture of iron to withstand molten aluminum under pressure. Would you recommend a charcoal iron as being suitable for this work? Any suggestions you may offer will be appreciated.

It is doubtful if any analysis of cast iron would be satisfactory for such service as exposure to molten almuinum under pressure. For die casting aluminum alloys, chrome vanadium steel has been found the best material, and this material would also be the most satisfactory for the pumps also. It would be advisable to experiment with monel metal as this alloy can be cast and the parts now being made of cast iron could also be cast of monetl metal. A high chromium alloy resists the destructive influence of molten aluminum in a satisfactory manner and castings of such alloys also can be obtained.

Prevents Sand Sticking to Pattern Plate

We have made pattern plates from a mixture of 92 per cent aluminum and copper 8 per cent. We had good results with the alloy as far as the castings were concerned, but when the plates were used we found the sand would stick to them, making castings that were not smooth as they should be. The plates seem to be covered with a greasy material to which the sand sticks. We have used parting powder and lycopodium without any improvement. We also have given the plates a thin coating of bright varnish, but after a few molds the sand will again stick to the patterns. Will you kindly tell us how to avoid this trouble.

Perhaps in finishing and polishing the plates they get coated with a film of oil or grease. This should be removed by washing with kerosene or naphtha, which must be thoroughly wiped off after which the plates are warmed and coated with beeswax by brushing the warmed plated with a stiff bristled brush, which has previously been vigorously rubbed over a lump of beeswax. This will remove all stickiness from the plate, and if the sand still continues to stick, it is due to some other cause than a sticky film on the surface of the plate. In this case, clean the plate with a light hydrocarbon oil to remove any grease, then give it a thin film of kerosene oil. When the plate is in use each time the

sand begins to stick, clean the plate with a soft brush and wipe it over with kerosine.

A scheme frequently adopted to prevent plates sticking is to keep them heated while they are being used. Sometimes small gas flames are used for this purpose. They are kept burning underneath the plates; a more progressive method is to use electricity for the same purpose.

Aluminum Alloy for Use in Permanent Mold

We are figuring on making aluminum castings in a cast iron, permanent mold. We would like to get a mixture that could be buffed, take a high polish, and also keep from tarnishing and in addition to all these qualities, would be noncorrosive

Use the following alloy: Copper 8 per cent, aluminum 92 per cent. This is known as No. 12, aluminum and is best made by melting 16 per cent of a hardener composed of half aluminum and half copper with 84 per cent of commercially pure aluminum. This alloy will approach the qualities demanded as well as any alloy. It casts well, can be buffed, will take a high polish, but cannot be expected to retain this polish indefinitely. It is noncorrosive to some agents and corroded by others, like all other metals and alloys known to science. If the castings crack in the iron molds, increase the copper to 12 per cent.

Brass Retains Aluminum Oxide

We are making yellow brass castings to withstand pressure. These castings must also be smooth in order to polish readily. The addition of aluminum makes a smooth surface and a satisfactory one, but greatly increases the leakage. The omission of aluminum would lower the leakage loss but on account of the high temperature at which it is necessary to pour these castings the surface would be so rough the polishing cost would be greatly increased. We have thought of adding manganese in the form of manganese copper, and would like to learn what the results would be and how much should be added.

The addition of manganese to the mixtures will not counteract the effect of the aluminum in causing leakage. One of the evil effects of adding aluminum to any metal or alloy is the formation within the metal of an insoluble oxide which is largely retained, and in the case of brass, this oxide being nonmetallic forms a convenient pathway for the passage of water or gases under pressure. Manganese will not affect this oxide in any way after it has once formed and it is our opinion that nothing can be done to lessen this leakage loss when aluminum is used in the alloy.

The only manner in which manganese or any other deoxidizer could assist matters would be in eliminating oxides before the addition of aluminum, then there would be a lessening of alumina in proportion to the lessening of oxides. For this to work it would be necessary to add the manganese to the melted copper, then the manganese oxides must rise to the surface, for if they are caught in the copper by the aluminum, the result would be the same as if no manganese had been added as far as leakers are concerned. It would work no harm to try the addition of 0.24 per cent of a 30-per cent manganese copper, but it must be added before the aluminum to be of benefit.

Acid Resisting Bronze

We would like to obtain a mixture for a bronze to resist the action of sulphuric acid.

The following alloy is largely used to make castings that will be exposed to the action of solutions of sulphuric acid in situations where the castings are not expected to be subject to high stresses. The alloy follows:

	Pounds
Copper	75
Tin	8
5 Per Cent Phosphor Tin	2
Lead	15

Melt the copper under charcoal, add the phosphor tin, then the tin and lastly the lead. Stir thoroughly to get the lead well mixed.

Partings for Brass Molds

We would appreciate any information on the subject of making partings for brass foundry work.

Modern mold partings consist of fine powders that do not readily mix with water. They are the outgrowth of the search for a substitute for lycopodium, once used for parting on molds, or rather it was used to assist the regular partings in preventing the sand adhering to the patterns.

Before these convenient parting materials appeared, it was customary to use ground rosin; also ground rosin and pounded charcoal mixed and dusted through a bag onto the mold. The charcoal and rosin mixture, however, has the disadvantage of being dirty to handle. The powdered rosin also is dirty and for this reason is not liked by the molders. In place of rosin it is the practice in some foundries to use burned molding sand obtained from the outside of heavy castings; it is dusted through a bag like the rosin parting. Any sharp sand can be used as a parting, but it rolls down inclined surfaces and in time coarsens the molding sand.

Bronze Friction Bands

We desire a formula for a metal suitable for making bronze friction bands. The mixture must have qualities of resilience, toughness, and heat and wear resistance. We have been using 88-10-2, *but it seems the metal becomes flaky.*

We suggest a trial of the following alloy:

Bronze Friction Bands

Copper	88.00 per cent
Tin	5.00 per cent
Nickel	5.00 per cent
Zinc	2.00 per cent

When melting, add about one ounce of phosphor copper to the charge and place it in the bottom of the crucible with the cold metal.

The physical properties of the above alloy according to the Bureau of Standards are:

Ultimate strength, pounds per square inch	40,680
Yield point, pounds per square inch	13,050
Elongation, per cent in 2 inches	31.8
Reduction of area, per cent	28.0
Modulus of elasticity, pounds per square inch.	17,300,000

Pours Brass against Iron

We would like to be informed if there is any substance we can put on cast iron that will cause brass to lay when poured onto the iron. We have had great difficulty pouring brass sleeves, which have a chamber in the center, and are poured in a horizontal position with a cast iron arbor.

There is nothing that can be coated onto the iron that will make the brass lie quietly because the agitation is due to the condensation of moisture on the iron from the atmosphere of the mold. The one thing that can be done is to have the iron at a temperature that will ensure the moisture cannot condense on it. The iron will have to be hot when laid in the mold, and the latter must be poured while the iron is hot. In addition to this requisite, the iron must be perfectly clean, being free from all rust or scale. If the castings are small it is not necessary to flow off any brass after the mold is filled, but if the castings are fairly large, it will pay to flow off a few pounds of brass through a riser in the cope cut down lower than the pouring sprue. If the hot iron crumbles to dust the prints in which it rests make them of a facing sand bonded with silicate of soda instead of water.

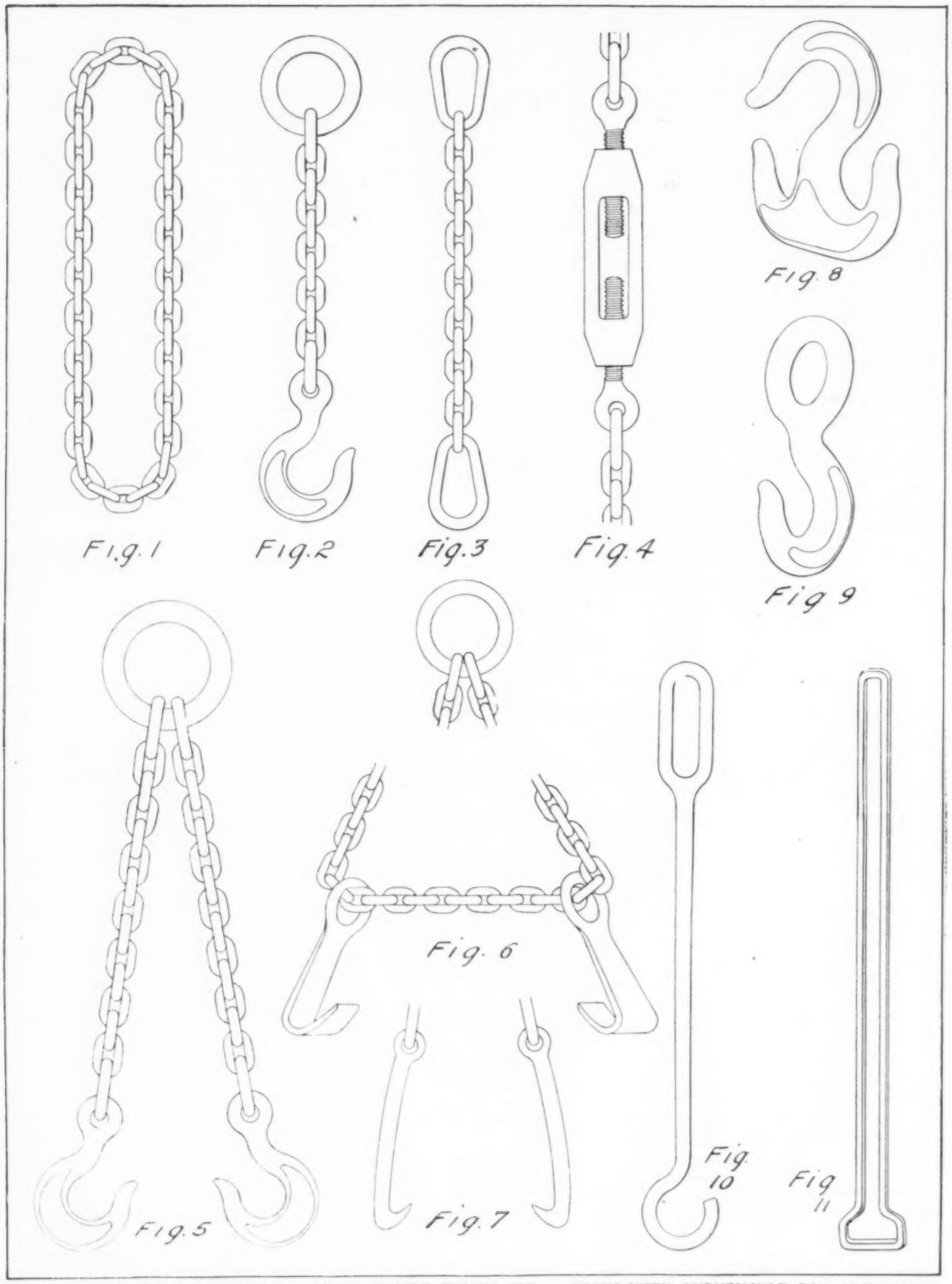


FIG. 1—DOUBLE SLING CHAIN FIGS. 2 AND 3—SINGLE CHAINS FIG. 4—CHAIN WITH TURNBUCKLE FOR ADJUSTMENT FIG 5—DOUBLE HOOK CHAIN FIG. 6—THE HOOKS MAY BE ADJUSTED TO VARYING HEIGHTS FIG. 7—PLATE HOOKS FIG. 8—DOUBLE HOOK USED FOR TRANSFERRING A LOAD FROM ONE CRANE TO ANOTHER FIG. 9—A SINGLE CHANGING HOOK FIGS. 10 AND 11—SLINGS USED IN CONNECTION WITH A BEAM OR CROSS

Chains and Slings for Foundry Use

Peculiar Conditions Prevailing in a Foundry Demand That the Chains and Slings Employed for Lifting the Flasks and Castings Be of a Distinctive Character

BY JOSEPH HORNER

ABSOLUTE steadiness of movement is a most important feature in nearly all operations. While finished, molds are being lifted, lowered, or turned over, or while heavy patterns are being delivered, the most exact levelling is essential. Ropes would be quickly damaged by heat and are not used for slinging. Further, their elasticity and stretch, and the facility by which they may be wrapped round work, an advantageous factor in the machine and erecting shops would be objectionable features in the foundry. No elasticity is permissible in handling molds that are likely to drop out, or in delivering of ingate, and other details can be employed for slinging and hoisting, swivels are used when boxes have to be set horizontally, and large patterns drawn.

When the crane is employed to lift an empty flask, the swivels at the ends, Figs. 12 and 13, are embraced by a double sling chain, Fig. 1, or a single chain, Figs. 2 and 3. The collars on the swivels retain the chain loop, or hook, or eye. When adjustments for leveling are required, the sling with a swivel, Fig. 4, is selected in preference to the others.

Spreader Is Employed.

When a box part exceeding a moderate length has to be turned over on its swivels, the chains must come down perpendicularly. They are then maintained apart by the insertion of a temporary prop or beam, put in before the *strain* of the lift is taken. A couple of bits or rod slipped into the links immediately below prevent the beam from slipping downward when the strain is put on. An alternative method is to hang a horizontal beam on the crane hook, and attach sling chains, or rigid rods like Fig. 10, to the beam. The box then can be rolled over without the slings coming in contact with the ends. Cleaning up, coring, the insertion of chaplet nails, the finishing of ingates, and other details can be done with facility while the box is suspended. If this would hold up the crane too long, the box is laid by its trunnions on iron trestles.

When a box has straight handles only, each handle must receive an individual sling chain, Fig. 2; but all of equal length. Boxes have two handles, or four. The first can be rolled over in the slings. In the second, the chains are removed from the side that is to be down while turning, and the box is lifted by the other two, until it is brought up on its edge, then it is lowered in the other direction. If the box is a long one, a beam or stretcher must be employed. Another method is to wrap an endless sling chain round the two handles on each side, then hook a sling chain from

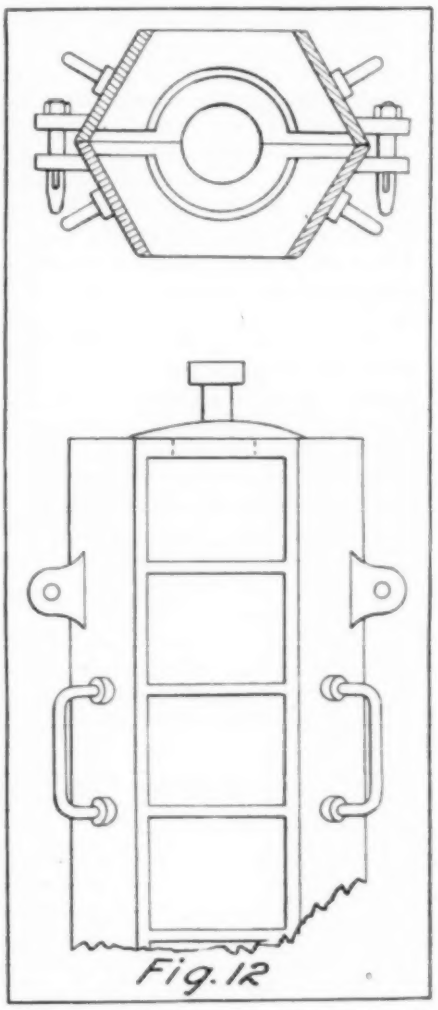


FIG. 12—TYPICAL FLASK PROVIDED WITH HANDLES AND SWIVELS

the crane to each, strain every portion to prevent jerks, and then lift edgewise, and turn over.

Many Varieties of Hooks

Fig. 5 illustrates two hook chains slung from a ring that is slipped over the crane hook. Fig. 6 is another useful form, which includes provision for setting the clips at varying horizontal distances, a bit of rod inserted in adjacent links preventing the clips from slipping inward under strain. Fig. 7 is a pair of hook grips, suitable for taking hold of the edges of boxes, or of back plates. Fig. 8 is a changing hook, used for transferring boxes, or ladles of metal. Fig. 9 is a single changing hook.

Sling chains are undesirable for lifting boxes over 6 or 8 feet in length. Rigid slings like those in Figs. 10 and 11 are used, because they hang perpendicularly, and can be moved along to any notch within the range of the beam, Fig. 14, to suit boxes of different lengths. Many of these beams are of wood, bonded at the ends. Fig. 14 shows one of cast iron. Beams of wrought iron are used to a slight extent, but those of cast iron do not break, and their dead weight is not objectionable. The rigidity of a cast iron beam also is of advantage when delicate movements are in progress. Wooden beams are subject to deterioration due to the heat.

Turnbuckles Are Necessary

The swivel, inserted in a sling chain, Fig. 4, is indispensable for all delicate operations, involving careful leveling. When a heavy pattern of large area has to be withdrawn by hand, two, three, or more men must be stationed at nearly equidistant points, to lift in unison, often with another man, or the foreman, directing the movements of each. If one happens to lift a trifle higher than the others, he must pause while they continue, in order that the pattern shall be withdrawn as nearly level as possible. In such cases, a crane lift is preferable, and in very heavy patterns, is essential. Then the level lift is secured through the sling chains, each attached to its lifting eye screwed into the pattern, while the strain is distributed equally by the adjustments of the turnbuckles. Afterward, the withdrawal can be done with little risk of fracture of pulling up of the sand. The lifting and lowering of box parts is done with the same precautions.

When a box part is lifted off a pattern, some parts of which come in the cope, a level lift is necessary to avoid fracture of the sand that is pulled off the pattern. Equally important is the level lowering of a cope part on a completed lower mold, especially so when the latter contains cores which stand up and come in contact with the cope; or enter print impressions in it. If the cope is

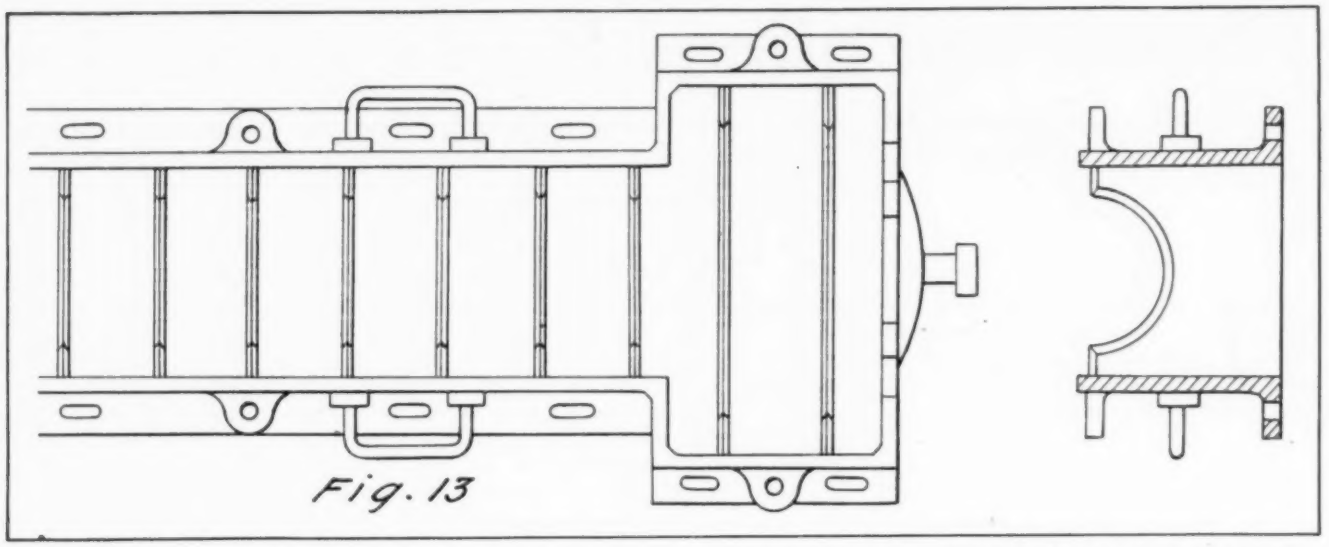


FIG. 13—FLASK DESIGNED FOR MAKING MOLDS WHICH ARE TO BE CAST ON END IN A PIT—HANDLES AND SWIVELS ARE SIMILAR TO THOSE IN FIG. 1

lowered out of level, it is liable to crush portions of the joint faces, and crush, or shift cores. In nearly all cases,—always in large work,—the cope is lifted after the mold has been closed in order to see that no damage has happened to the mold, and is then finally lowered and closed.

Handling Long Flasks

Another class of slinging done is connected with the lowering of deep molds into pits for casting on end. Boxes for this work have loop-like eyes, Figs. 12 and 13, cast at the sides near both ends, in which the hooks of the chains take hold. The same eyes afford assistance in turning over during the molding. Eyes being located near each end, the box can be lowered by either, to suit the mold which happens to be made in it. After the mold has been poured, it is lifted out in the same way. In Fig. 13, flanges are shown cast to receive back plates, which are necessary to retain the sand against the pressure of the metal in the deeper parts of molds. In their absence, sand is rammed against the backs of the molds.

Turning over is seldom necessary in loam work except when a ring has to be swept on opposite sides of a plate. Hence for almost all loam work, slinging is done with the cross Fig. 15, and rigid slings. The cross is a casting, supporting slings which loop the lugs on the loam plates and rings, Fig. 16. The notches accommodate various diameters.

Magnesite Production

The domestic magnesite industry enjoyed a good year in 1920. More magnesite was mined in this country than in any previous year except 1917. California and Washington are the only producing states. Preliminary figures given in the United States Geological survey press bulletin indicate a total output of these two states for the year 1920 as between 275,000 and 300,000 tons.

The Hill-Curtis Co., Kalamazoo, Mich., has purchased the grinding and polishing stand and accessory department of the Webster & Perks Tool Co., Springfield, O.

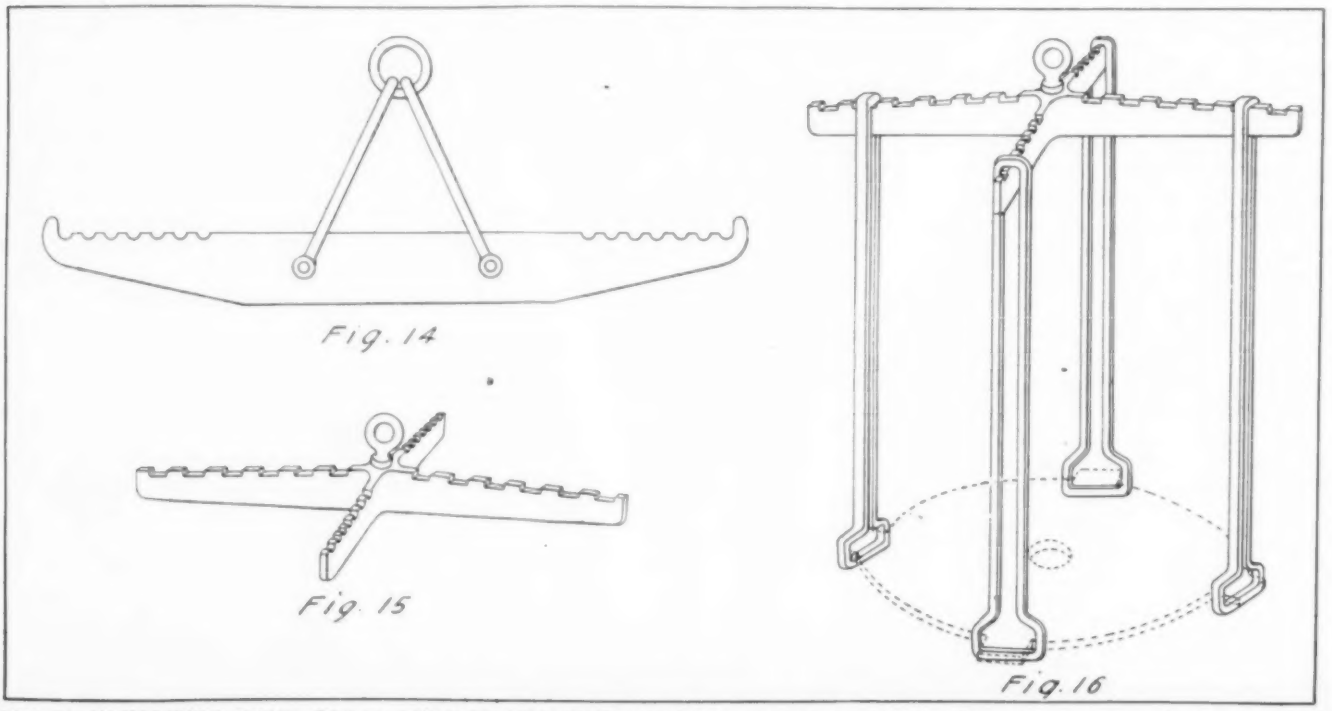


FIG. 14—EQUALIZING BEAM FIG 15—TYPICAL EXAMPLES OF CROSS USUALLY EMPLOYED ON LOAM WORK FIG. 16—SHOWING APPLICATION OF CROSS AND SLINGS

Powdered Coal Applied in Foundry

Description of the Layout and Operation of a Powdered Coal Installation Is Given and Claims for Its Economy in Fuel, Labor and Other Factors Are Made

BY A. J. GRINDLE

POWDERED coal has been used for annealing malleable castings for about fourteen years. Although the fuel saving has proved to be small, it has been found that great savings were effected in pot costs and labor. These savings encouraged experiments and many companies now have successful powdered coal installations used for both annealing and melting. It also has been proved that to get the best results with powdered coal as a fuel, it is necessary to dry the coal so that it will not contain more than 1 per cent moisture, and to pulverize it so that at least 85 per cent will pass through a 200-mesh test sieve.

When our company resumed business after the war I was anxious to solve the problem of malleable iron melting and secured our first contract from the National Malleable Castings Co., Cleveland. We made an installation of firing equipment on a 10-ton furnace at the plant of that company at Twenty-fifth street, Chicago. Our guarantee on this installation was a saving of $2000 per year. After a three weeks' run a saving of $5548 per year was indicated. This saving was not made on fuel alone, as is the general impression when talking about powdered coal. Savings are also made in the amount of pig iron necessary in the charge, labor and furnace repairs. Some of our customers also claim an increase in production from their molders by getting the second heat on time, which eliminates loafing by the molders, after their floor is filled, until the heat is ready.

Our company now has equipments in four malleable iron foundries, all of which are proving satisfactory, with the possible exception of our installation at the American Radiator Co., Buffalo. Here the coal is pulverized mainly for sea coal, 44 per cent passing through a 200-mesh test sieve. Also the coal is not being dried. Powdered coal of this kind causes a long flame and much of it does not burn until it reaches the stack. Another difference from the general practice at this plant, is that the heats are not skimmed. After the iron is out, the slag is tapped from the furnace through a hole approximately 5 x 9 inches. This method eliminates much of the hard labor in skimming, but in my opinion more fuel as well as a longer time in heating up is required.

The author is president and chief engineer, the Combustion Economy Corp., Chicago.

Will Try Dry Coal

As soon as sufficient work is secured by the American Radiator Co. they intend to start this furnace again, pulverizing their coal finer and drying it, as well as installing one of our pneumatic conveying systems. Also tests will be made with heats which are skimmed and other heats not skimmed, operating the equipment exactly the same way in both cases and comparing results.

After our first installation of firing equipment, we found it to be necessary to convey the coal from the pulverizing plant to the furnace hopper in some simple manner. Our engineers, therefore, designed a pneumatic conveying system for conveying the coal through a 4-inch pipe line. Although the first one was not sufficiently successful to place it upon the market, we finally developed a conveying system which is now in successful operation at the plant of the National Malleable Castings Co. and at the Kalamazoo Malleable Iron Co., Kalamazoo, Mich.

By this method, the pulverizer cyclone is set directly on top of a powdered coal storage hopper of any desired capacity. On the bottom of this hopper is a valve through which the coal may be charged into a round tank, built to stand air pressure up to 80 pounds per square inch. A specially designed casting which we call our pneumatic conveyor feeder is located on the bottom of the tank. This casting has a series of air jets and sets on a scale with the tank. The discharge end of the casting is tapered down to fit a standard pipe flange. Standard pipe is then run from this point to hoppers at the different furnaces.

A switching valve is supplied for each hopper, and when the operator of a furnace needs coal he opens the valve to his particular hopper. When opened this valve closes an electric circuit which lights a light on a signal board at the feeding tank representing that particular valve. A map of the line and a light representing each valve are on this board. When the operator of the conveying system sees this light, having previously loaded the tank with powdered coal, he opens a compressed-air valve which immediately starts the coal through the pipe. After a two-minute run the coal travels at the rate of 1000 pounds per minute with a maximum air consumption of 350 cubic feet per ton of coal conveyed. When the hopper is filled, the valve automatically closes, putting out the light, and the coal continues on to the next open valve, if there is one. If no other valve is open the air is automatically shut off at the feeding tank and the coal stops. One interesting point, and a question which often comes up, is the possibility of the pipe line becoming plugged. This has not occurred with our system since the installation of the first one, as approximately four times as much air in volume is used for blowing the coal as the volume of the coal. The pipe could not be more than one-fourth full if the coal immediately stopped when the valve was closed, and as we generally have at least one valve open on the line the coal seems to travel on, leaving a very small amount in the pipe even after the air is stopped.

Melts Malleable

Getting back to melting malleable iron, I wish to point out the necessity of having an accurate control of the fuel and air supply as well as proper furnace design. A man will eventually become an expert in firing powdered coal, and can then get fairly satisfactory results, but if this operator should leave the job for any reason it would take some time for another operator to reach the same point of efficiency. In our equipment we use a variable speed adjustment for controlling the supply of fuel and in connection with this a graduated dial which shows the speed at which the screw is traveling. The air supply is also controlled by a specially designed air valve which has a graduated dial attachment. Our operating man handles the equipment for a few heats, learning the best operation for the particular furnace, and makes a schedule for the most satisfactory operation. I have been told by the furnaceman at the Kalamazoo Malleable Iron Co.

that the flues are seldom looked at, but the furnace is fired according to the schedule, bringing the heats out on schedule time with a uniform grade of iron.

By applying the burners to the furnace, blowing downward toward the bottom of the charge and on the bath after the charge is melted, we have been able to eliminate the top blast which we have found to cause both excessive oxidation of the metal and also unnecessary burning of the brick work. The only necessity for having a top blast on the furnace is to carry the flame downward on to the bath, which moves the slag and top iron towards the back of the furnace, creating a circulating motion. This is accomplished with our burners without the aid of the top blast and partly accounts for the long life of the brick work on the furnace and the low pig iron requirements in the charge. The roof of our powdered-coal-fired furnace is easier to keep in repair, owing to the straight flat back without any wind bungs or other special bungs.

Economy of Brick

On the average hand-fired furnace approximately 19 brick are used per ton of iron melted, while with powdered coal only 9 brick are used per ton of iron melted. The walls of a powdered-coal furnace burn down evenly and the slag line does not burn in as bad as on the hand-fired furnace. From two to four hours are saved per day on firing time, depending upon the size of the furnace. One man is all that is necessary to fire and skim the furnace, excepting that it is sometimes necessary to give him some help to take care of the slag as it is skimmed off.

Our company is now working out an automatic control equipment to make the necessary changes on the fire during the heat. We start with a slow fire, gradually increasing the coal and air as the iron melts down. This is accomplished by simply turning a crank, but the fireman's job is so easy that he sometimes forgets to make the change at the necessary time. The automatic control will make these changes on schedule time.

The average charge on a powdered coal furnace consists of 40 to 45 per cent pig iron, 10 per cent malleable, 10 per cent steel, and the balance hard scrap. This may be compared to the average hand fired practice of 50 to 60 per cent pig iron in the charge, which reduces the amount of malleable and steel scrap which can be used.

We are now melting 10-ton first heats in 4½ hours, second heats in 3 hours; 15-ton first heats in 5 hours, second heats in 3½ hours; 24-ton first heats in 6½ hours and second heats in 5½ hours. The fuel consumption is between 3 and 4 to 1, depending upon the size of the heats, quality of coal used, and size of the furnace. The larger heats, providing the furnace is properly built, can be melted with 25 per cent or less coal to iron, using coal containing 13,500 B.t.u.

By using powdered coal for annealing malleable castings it is possible to make substantial savings in fuel, labor, and pot costs. An oven fired with powdered coal, as well as a hand-fired oven, should have more space above the pots, or if it is a muffel oven above the inner arch, where the fire enters. This is desirable because the gases are much more expanded at this point, and the oven can be forced harder without danger of burning the pots or arch if it is properly constructed. It is also necessary to have a net work of flues in the bottom of the oven, a single flue along each side being sufficient. This flue should have openings in the floor approximately 5 feet apart for cleaning out the ash. It is necessary to clean these flues only about once a month, providing they are made about 9 x 15 inches, or a little larger, depending upon the size of the oven and the amount of ash in the coal. The labor of cleaning this ash from the flues is much less than that for disposing of the ash from under the grate on a hand-fired oven.

Annealing temperature can be safely reached with powdered coal on a 20-ton pot oven in 30 hours. A 20-ton muffle oven requires from 40 to 45 hours to reach annealing temperature. We have also raised 50-ton pot ovens to annealing temperature in 25 hours, but this is not practical, owing to the excessive heat on the top of the oven before the bottom reaches temperature. We are also firing one muffle oven, 40 feet long, with a capacity of from 70 to 90 tons of castings. It takes from 55 to 60 hours to reach annealing temperature of this oven. On pot ovens the fuel consumption runs from 500 to 700 pounds of coal per ton of castings annealed, depending upon the capacity of the oven, amount of packing used, and the weight of the pots. Muffle ovens require from 600 to 800 pounds per ton, depending upon the capacity and construction of the ovens.

The annealing pots in a powdered coal oven will last on an average of 18 anneals, while with a hand-fired oven the average life of pots is about 12 anneals. This saving alone would warrant the installation of powdered coal equipment, if there were no other savings. The pot saving is accomplished by the decreased amount of excess air necessary for combustion, and the ash which deposits on the pots helps to protect them.

The labor required to fire a powdered coal oven amounts to not more than one hour per day for each oven, and in some plants the annealing room foreman fires the ovens in the day time and the watchman takes care of them at night. No other firing labor is necessary, unless there are several ovens in a plant to watch.

Companies using powdered coal for annealing have told us that they have run ovens for three and four years without using a brick for repairing the oven. When firing an annealing oven with powdered coal, ash collects on the brick work and protects it. Sometimes it is necessary to knock this ash off the brick, which is easily accomplished without harm to the brick work.

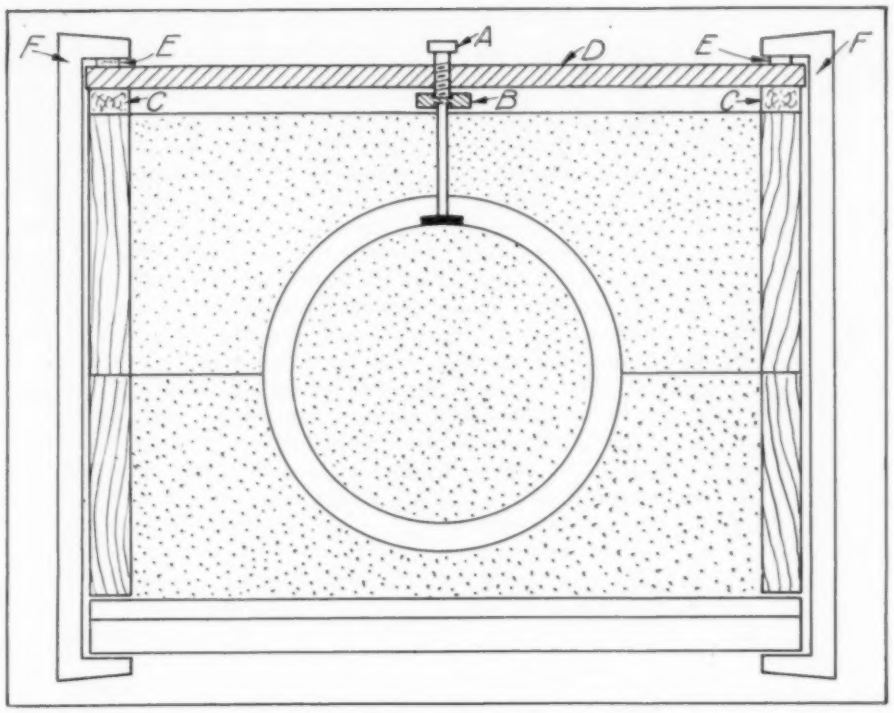
Where a malleable iron company generates its own heat and power, and has a powdered-coal installation, substantial fuel and labor savings can be made in the boiler room. As high as 80 per cent efficiency can be obtained, or a saving of approximateliy one-third of the coal, depending upon the design and capacity of the boiler and method of firing. Not only is less coal required, but a saving of labor and grate bars is also effected.

Chaplet Can Be Tightened Down With a Bolt

By Michael R. Burns

The device shown in the accompanying illustration is one that I have found extremely convenient and a decided improvement over the ordinary method employed for securing chaplets in the cope of a mold. Usually a bar is placed across the cope at some distance above the top of the chaplet, the ends are clamped down and then the molder inserts blocks or wedges between the bar and the top of the chaplet. It is a ticklish operation and unless it is carried out carefully the movement or strain imparted to the core by the rising metal will dislodge the blocks and wedges and the result will be a shifted core and a scrap casting.

In the device shown in the accompanying illustration there is absolutely no chance for the rigging to shift or slip. Only one application of the device is shown but it can be adapted to fit practically any condition. Thus instead of a single bar it may take the form of a *Y* or a *T* or a circle, with chaplet holes drilled through it at as many points as the character of the cores in the mold require. Two or more clamps are employed to at-



WHEN THE BAR IS CLAMPED DOWN AND THE BOLT TIGHTENED THERE IS NO CHANCE FOR THE CHAPLET TO SLIP

tach it firmly to the flask and then the bolts over the chaplets can be tightened down individually.

In the illustration the bar *D* which may be of any width and thickness, depending on the size of the core it is intended to hold down, rests on the two blocks *CC* on top of the cope. It is held down by the clamps *FF* which in turn are tightened by the wedges *EE*. The bolt *A* can be raised or lowered through a drilled and tapped hole in the bar *D*. The iron block *B* is drilled and tapped for about half its thickness on one side so that it can be attached to the bolt *A*, but the other side is only recessed about ¼-inch deep to receive the end of the chaplet stem.

In practice the bar is adjusted on the cope so that the bolt and block will come straight above the chaplet or chaplets. It is clamped in that position and then all that is necessary is for the molder to tighten down on the bolts until they feel tight.

Making a Green-Sand Smokestack Mold

By R. C. Brown

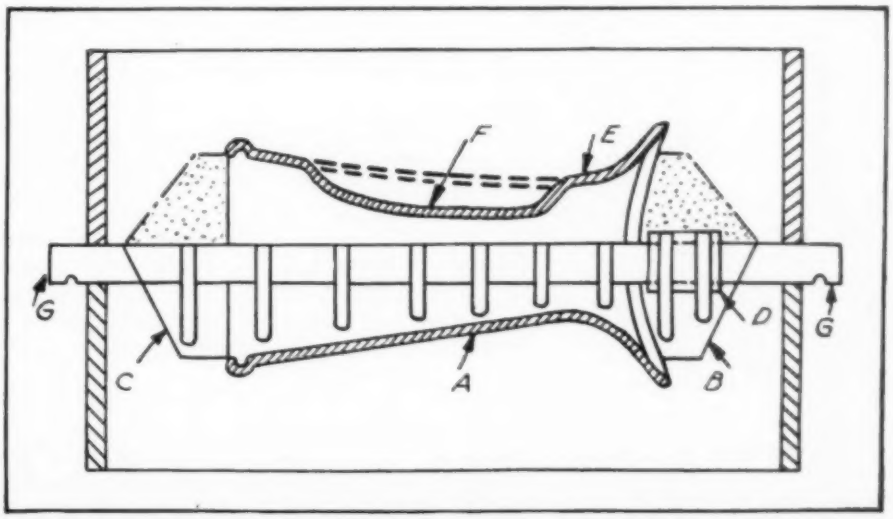
In an old copy of THE FOUNDRY for March, 1920, several methods are described for making the smokestack castings in common use on tractors in the agricultural regions of the country. Each method has its advantages under certain circumstances and each method, of course is capable of turning out satisfactory castings. The method shown in the accompanying illustration has been developed by a prominent foundry in the Middle West and is both simple and practical.

The pattern is a split-shell iron pattern made from a regular casting sawed in two longitudinally and provided with dowels on the joint for locating each half in its proper relative position when the two halves are assembled for molding. In making the mold, the drag half of the pattern *A* first is laid on the follow board which is shaped at the ends as shown at *B* and *C* to make a sloping parting. After the drag has been rammed, rolled over and the follow board removed, parting sand is spread on the parting and a snug fitting arbor consisting of a backbone and a number of wings spaced about 6 inches apart, is lowered into the mold and rammed up flush with the joint of the pattern. The arbor is provided with a trunnion *G* at each end for lifting it and also for supporting the weight of the core on the flask ends after the pattern has been taken out of the mold. The two wings *D* on one end of the arbor do not form an integral part of the arbor but are slipped on the back bone and tightened by wooden wedges. After the casting has been poured and shaken out the wedges are removed and the wings taken off. The arbor is then pulled out through the other end of the casting.

Having rammed the arbor flush with the joint of the pattern, the cope half is set on and rammed full of sand, access being had through both ends and through an opening shown at *F* which has been provided for that purpose. A parting like that indicated in the illustration is made at each end and a shell corresponding to the shape of the opening in the top of the pattern is tamped into place; after which the cope is set on and rammed in the usual manner. A gate pin is set near the center of one side and a small riser taken off the highest point at each end.

The cope is lifted off, bringing the top half of the pattern with it, by means of two screws which are attached by tapped holes in the pattern, one at each end. The cope then is turned on its back and finished after which the core is lifted out of the drag and set down while the bottom half of the pattern is being drawn.

Having finished the drag the core is replaced, followed by the cope. The mold is then clamped together, a runner made up and a wedge slipped in between the arbor shank and the flask at each end to prevent the core from lifting when the metal is poured in.



COMPOSITE VIEW SHOWING SECTION OF MOLD WITH ARBOR AND PATTERN IN PLACE

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Seeking a Shock Absorber

DURING the period of depression, practically every foundryman has been confronted by a dearth of orders for the castings which his plant previously produced. When new inquiries slumped he looked about, and as the greenest pastures always lie on the other side of the fence, he sought to develop new lines of work. Sash weights appealed to many. In fact, the few months just past might be designated as the sash weight period in American foundry practice, without applying a serious misnomer. Simplicity, ease of molding, the absence of metal specifications and the apparent ready market for this foundry product doubtless rendered the humble sash weight such a general favorite. Probably some were successful in entering this market, and may have found in casting sash weights a temporary outlet for extra metal if not some actual relief from the general depression. However, in the period now at hand, the specialist will thrive, and he who ventures on unfamiliar practice will be handicapped. A study should be made of the field at hand. Consider the foundry making pistons for automobile engines. Admittedly, business in new cars is in doubt, but replacements alone will create a sizeable demand. A truck publication, *The Chilton Commercial Car Journal*, estimates that Ford trucks alone will use 780,000 pistons for replacements this year. The moral is obvious. Specialize and stick to familiar lines if humanly possible. In the period of keen competition upon which the industry is entering efficiency and low production cost will spell survival. Furthermore, foundries must cultivate the markets which exist, for their castings. No business is seeking the producer in these times.

Demands on Castings Increasing

NOTWITHSTANDING cast iron is deficient in elasticity and, in the form of white iron, is exceedingly brittle when measured by the standard of cast steel, it has for many years given admirable service in the chilled iron car wheel where not only the natural brittleness of the material might be thought to be a severe handicap, but where the enormous chilling strains must be partially neutralized to enable the wheel to undergo the severe grilling it receives in service. With heavier loads on both the individual cars and on the trains the duty of the wheel has become increasingly severe and the railroad metallurgists are no longer content to accept wheels on the standard chill test, drop test and tape test alone, but insist on chemical limits in the specifications. As a result of this demand, the American Society for Testing Materials has adopted tentative specifications requiring limits for silicon, sulphur, phosphorus, manganese and combined carbon. With these limits as adjuncts to the physical tests which the wheels now must stand, it is thought that fewer wheel failures will result in service. Back of both the physical tests and the chemical analyses is the foundry practice which must be thoroughly studied and maintained from day to day. As an aid to this the analysis of the raw materials and of the product has for a number of years been employed and now the field of pyrometry is being opened by the development of instruments to determine the temperature of the metal as it flows into the ladle. The pouring temperature, so important to many castings thus may be definitely regulated.

Trade Outlook in the Foundry Industry

CONTROL which fundamental business conditions exert over every branch of industry seldom is manifested so plainly as at the present. In fairly normal times little is thought of the basic conditions of business, but causes are looked for more in the individual branch affected. Now, however, a broad general view must be taken to determine the future course of the foundry trade. Encouragement is lent to the situation by the recent reduction of the rediscount rates to 5½ per cent by four of the Federal reserve banks, and by the reserve ratio of the associated banks of the Federal reserve board which was reported as 63⅜ per cent on July 21. Thus, easier money facilitates investment and at a certain point this movement will acquire enough momentum to speed industry.

Railroads Hold Key

In line with this slant of the situation is the government plan now tentatively agreed upon to pay the railroads the $500,000,000 on account for capital expenditures made during the war. Part of this money will be used to pay off debts of the railroads, and passing on from one debtor to another materially will reduce the amount of money needed to carry loans. The other part of the government's payment will be used to purchase equipment of which practically all the roads are badly in need. Already a noticeable volume of car repair orders is being received and a number of roads are ordering new equipment. Freight cars on order and undelivered June 30 amounted to 12,149 for domestic account and 3711 for foreign. The increase in repair part orders and inquiries has not been felt so much by the foundries, because a smaller percentage of castings enter into car repairs than into new cars, but evidence appears to indicate that the foundry melt is being increased in some districts due to car repair work.

Prices of Raw Material for Foundry Use

CORRECTED TO JULY 28

Iron		Scrap	
No. 2 Foundry, Valley	$19.00 to 20.00	Heavy melting steel, Valley	$11.50 to 12.00
No. 2 Southern, Birmingham	19.00 to 21.00	Heavy melting steel, Pitts.	12.00 to 12.50
No. 2 Foundry, Chicago	19.50 to 20.00	Heavy melting steel, Chicago	10.25 to 10.75
No. 2 Foundry, Philadelphia	20.85 to 22.00	Stove plate, Chicago	13.00 to 13.50
No. 2 Foundry, Buffalo	20.00 to 22.00	No. 1 cast, Chicago	13.50 to 14.00
Basic, Valley	18.00 to 19.00	No. 1 cast, Philadelphia	16.50 to 17.00
Basic, Buffalo	20.00 to 21.00	No. 1 cast, Birmingham	13.00 to 13.50
Malleable, Chicago	18.50 to 19.50	No. 1 cast, Buffalo	12.00 to 12.50
Malleable, Buffalo	21.00 to 22.00	Car wheels, iron, Pittsburgh	13.00 to 13.50
		Car wheels, iron, Chicago	12.50 to 13.00
Coke		Railroad malleable, Chicago	13.00 to 13.50
Connellsville foundry coke	$ 4.00 to 4.50	Agricultural mal., Chicago	13.00 to 13.50
Wise county foundry coke	6.00 to 7.00	Railroad malleable, Buffalo	11.50 to 12.50

Foundries Buy Iron

Pig iron buying has been stimulated by price cuts in practically all sections and more inquiries are out Possibly some business is being held back in anticipation of lower prices if freight rates are cut as now seems probable. It is known that conferences have been held to bring about this result and talk is current of a 20 per cent reduction such as Henry Ford is putting into effect in the case of Ohio coal on his Detroit, Toledo & Ironton line. Such a reduction, it is figured, would reduce the production cost on pig iron materially. However, the stocks in some foundries are running low and purchases of iron are being made in such cases. In a few cases forward purchases covering the last quarter of the year are being made which is an indication that some foundrymen think the bottom of pig iron prices has been reached. One eastern Pennsylvania furnace reported that up to the fourth week in July, it had sold five times as much iron as in the whole of June. This is not saying as much as seems apparent on the surface as the total sale for June was exceedingly small. However, it does indicate progress in the right direction.

Outlook for Castings

A large potential demand for castings is created in two large projects in the East; the one the proposed vehicular tunnel to connect the island of Manhattan to Jersey City and the other the proposed Delaware river bridge to connect Philadelphia and Camden. The latter will require approximately 2000 tons of steel castings. Both malleable and gray iron foundries are helped by the demand for automobiles which has been maintained at a greater rate than was expected. Even though this is at present between seasons, being after the spring demand and before the fall trade starts it is stated that business now on hand will insure present operations through the month of August. In the state of Michigan, present production is placed at about 7500 cars daily, or 70 to 75 per cent of capacity. With this output, the stock supply of castings is being used rapidly and some companies are forced to place orders with foundries. Recently the Continental Motors Corp. announced receipt of a large order for motors for the Durant Motors, Inc., a new company which will manufacture a four-cylinder car. Jobbing foundries in St. Louis are getting a few orders and are following the plan of pooling this business, effecting economy by letting one plant make the castings. Orders for stove castings are not brisk although the building of houses over the country has not been so greatly curtailed. Sales of farming implements have increased slightly as farmers who had thought to get through the season without purchasing machinery have found this necessary at harvest time and are making a few purchases. While sales of cast iron pipe are slow on the Pacific coast where lettings are small, Chicago reports that inquiry for cast pipe shows a better volume than it has for several months. Milwaukee is asking for bids until Aug. 10 on 3510 tons.

Nonferrous Prices

Prices on nonferrous metals have had marked and steady reductions in the past month with the exception of lead which is still quoted at the same price as a month ago. Prices based on New York quotations in the *Daily Metal Trade* of July 28 are: Casting copper, 11.25c to 11.50c; electrolytic copper, 12.00c to 12.25c; lead, 4.40c; antimony, 4.65c; Straits tin, 26.25c to 26.50c; aluminum, No. 12 alloy, producers' price, 23.80c to 24.00c; open market, 16.00c to 17.50c. Zinc is 4.25c to 4.30c E. St. Louis, Ill.

Repair Inquiries Presage Betterment

Increasing Volume of Orders for Replacement Parts Encourage Foundry Equipment Manufacturers — New Plant Construction Continues Slack in All Sections

ONE of the most favorable factors in the foundry equipment outlook is the growing volume of inquiries and orders for repair parts. This interest is evidence of returning confidence and points to an expectation of resumption all along the line in the early fall. One manufacturer of molding machines reports orders for replacement parts, which if continued in undiminished volume would establish a fair operating schedule for the plant. Increasing interest in various types of melting equipment as well and the purchase of parts for that already in service is another characteristic which has been noted recently. Several gray iron shops have installed small cupolas to use until increased business will support the economical operation of their larger furnaces. The Ohio Steel Foundry, Lima, O., recently has placed a contract with Arthur G. McKee & Co., Cleveland, for a new open-hearth unit. The Self-Lock Nut Co. has purchased a plant and machine shop at Constantine, Mich., for its own product and for jobbing work. It at present is equipping this shop for malleable production. The Ladel Co., New Philadelphia, O., has purchased a cupola from the Whiting Corp., Harvey, Ill.

New York Inquiry Listless

WITH foundry operations at low ebb, due to a combination of industrial inactivity and hot weather, demand for equipment continues listless. Few new projects are noted and such inquiry as is now current involves principally single items. Several foundries in the vicinity of New York are figuring on equipment in anticipation of obtaining contracts in connection with proposed vehicular tunnel between New Jersey and Manhattan. However, contracts for this work have not been awarded and consequently no orders are being placed. One foundry concern in the vicinity of Newark is reported to be asking for estimating figures on a list of 12 cranes, ranging from two to 7½ tons capacity, in addition to miscellaneous equipment. Six are jib cranes. Prices still tend downward. One manufacturer recently reduced prices on sand blast machinery between 10 and 15 per cent and this was followed by several other manufacturers of similar equipment. Reductions of as high as 20 per cent have been made in flasks. Recently, the General Electric and Westinghouse companies reduced prices on motors and other electrical equipment 10 per cent and this reduction has been pretty generally met by other manufacturers of electrical supplies.

Better Prospects In Chicago

WHILE immediate business in foundry equipment is slack, signs are appearing that give much hope of better things. A commission has been given to engineers for a malleable foundry which will be built at once in the Chicago district and other projects which have been held back for some time are being figured again with every prospect of their materializing at the better cost that now prevails. Engineers are doing considerable work planning rearrangement of existing foundries to increase production and this will bring out demand for additional equipment. A builder of cupolas has been able recently to sell a number of these as replacements for installment during the present lull in foundry activity. Some prospects are appearing for molding machines and similar equipment which promise to become orders within a short time. Supplies are not being bought freely, a natural result of curtailed operation which is the rule. To replace its large foundry, machine shop and repair works destroyed by fire in April, the Tomahawk Steel & Iron Works Co., Tomahawk, Wis., has purchased a new site along the Chicago, Milwaukee & St. Paul railroad and is having plans prepared by W. P. Ireland, local engineer, for a brick and steel plant, which will cost about $75,000, including equipment, to be practically new throughout. Castings, stoves and general machinery will be manufactured by the Riverview Foundry Co., which has been incorporated at Silver Lake, Kenosha county, Wis., with a capital stock of $10,000 by R. C. Dixon. Eighty acres of land at Rice Lake, Wis., have been purchased for $18,000 by the Brunett Perfect Heating System Co., formerly of Minneapolis, which will build a foundry and manufacturing plant costing about $100,000. The corporation is capitalized at $1,250,000, and is backed by J. L. Burnett and Harry S. Swenson, Minneapolis.

Improvement Shown In Pittsburgh

FROM all appearances it would seem that improvement slowly is gaining headway in the foundry equipment market in the Pittsburgh district. This is evidenced not alone by inquiries received, which are becoming more numerous, but by the few orders being placed as well and by the fact that foundries are ordering repairs for machinery. These are coming in both by telephone and telegraph with instructions to rush shipment by express. Recent sales reported by the J. S. McCormick Co., include a complete foundry installation for the Grottoes Foundry & Machine Corp., Grottoes, Va. The order calls for a cupola, complete with lining; two cranes and buggy ladles; core ovens; core machine; motor-driven blower, sand mixer and air compressor two tumbling mills and an embossing press for pattern letters, together with pneumatic tools, supplies, etc. A user in a nearby district has closed on one core oven with this same seller and a foundry and machine shop in Monessen, Pa., awarded it three core ovens. Occasionally a few of the many pending inquiries for molding machines turn into orders, according to advice received from the Herman Pneumatic Machine Co. Orders for five or six machines recently booked come from widely scattered points; two from the Kansas City plant of the Griffin Wheel Co.; one from the Queen City Foundry Co., Denver, Colo.; and one each from the Chapman Valve Mfg. Co., Indian Orchard, Mass., and the Hunt Spiller Mfg. Co., Boston. The Pittsburgh Electric Furnace Corp., this week is shipping an electric furnace to Spain for a fairly sizable foundry and likewise recently received an order for a furnace for the production of automobile castings in that country. The last domestic order received, however, involved two furnaces for monel metal in a rolled steel plant. Foundries continue their policy of deferring action on prospective crane purchases and few if any new inquiries are being received by sellers of crane equipment for foundry use.

Comings and Goings of Foundrymen

ROSS C. PURDY, consulting ceramist, former director of research for the Norton Co., Worcester, Mass., and professor of ceramics at Ohio State university, Columbus, O., from 1909 to 1912, recently was elected general secretary of the American Ceramic society of which he formerly had been president. Beginning with the time Professor Purdy entered Syracuse university in 1895 as a student, his life practically has been devoted to the study of ceramics. In 1896 he entered Ohio State, but due to the death of his father he was forced to take only a short industrial course in ceramics. He won the National Brick Manufacturers association scholarship which enabled him to take part time work on requirements for a degree in 1898-99. From 1899 to 1903 he was a chemist and superintendent in floor tile and pottery factories and from 1903 to 1905 was assistant in the ceramic laboratory at Ohio State. The next two years he spent as assistant professor in ceramics at the University of Illinois, Urbana, Ill. and as ceramist for the Illinois geological survey. He was the first instructor in ceramics at Illinois and organized the department. Then followed two years as associate professor in ceramic engineering at Ohio State and three years as full professor. The next seven years, 1912 to 1919, Professor Purdy spent as director of research for the Norton Co., following which he became a consulting ceramist until his election as secretary of the society. He was president of the society in 1909 and 1910. Professor Purdy is a member several technical organizations and clay products committees and chairman of Committee C-8 on Refractories of the Aemrican Society for Testing Materials.

J. D. Tipple has sold his interest in the Iron City Pattern Works and has opened the Alabama Pattern Works at 4000 Tenth Ave., Birmingham, Ala.

John D. Hurley, president, the Independent Pneumatic Tool Co., 600 West Jackson Boulevard, Chicago, sailed July 16 for an extended business trip to Europe.

Robert S. Hammond, formerly manager of the Pittsburgh sales office of the Whiting Corp., has been appointed manager of the Chicago sales office of the same company and is succeeded at Pittsburgh by S. C. Wilson, formerly assistant manager there.

James M. Cherrie, Springfield, Vt., recently has been made foundry superintendent for the Athol Machine Co., Athol, Mass., succeeding George Croak, who recently resigned to engage in the foundry business in Boston.

Vance McCartney, formerly with the Edward R. Ladew Co., a subsidiary of

ROSS C. PURDY

the Graton & Knight Mfg. Co., has been elected vice president of the Chicago Belting Co. His experience covers service with the Fairweather & Ladew Co. and the Edward R. Ladew Co. in the belting department.

Zechariah Chafee, president and treasurer of the Builders Iron Foundry, Providence, R. I., has been re-elected to the board of trustees of Brown university of that city to fill the Episcopal vacancy created by his own resignation.

Walter G. Bunzl, formerly chief engineer of the Richmond Radiator Co., New York, is now associated with the Pittsburgh Electric Furnace Co., Pittsburgh, at its New York offices, 149 Broadway.

George F. Croak, for the last year manager of the Athol Machine Co., Athol, Mass., has moved to Boston, where he has organized the George F. Croak Foundry Co., which has purchased a foundry in the Dorchester district.

Arthur A. White, vice president of the Barnes Foundry Co., Jersey City, N. J., who recently was made vice president of the Automotive Foundry Co., Freeland, Pa., recently has removed to Freeland. Mr. White retains his connection with the Barnes Foundry Co.

John H. Patterson, president of the National Cash Register Co., Dayton, O., has retired after 37 years as head of the company. As president he is succeeded by his son, Frederick B. Patterson. His duties as general manager have been assigned to J. H. Barringer.

Myron E. Vaughn, who until recently was foundry superintendent for the Otter River Foundry Co., Otter River, Mass. and previous to that time was with the Rodney Hunt Machine Co., Orange, Mass. has taken up the study of mechanical engineering at the Ohio Northern University, Ada, O.

William S. Fisher, St. John, N. B., who was recently elected president of the Canadian Manufacturers' association, is president of the Enterprise Foundry Co., Sackville, and vice president of Emerson & Fisher Ltd., St. John. He was president of the St. John Hardware association in 1907, president of the St. John Board of Trade in 1896 and 1897 and president of the maritime branch of the Canadian Manufacturers' association from 1914 to 1918. In 1918 he was called upon by the war purchasing commission to take charge of the outfitting of the first construction battalion in France, and in April, 1917, the Canadian government appointed him commissioner in charge of the dominion rifle plant at Quebec, Que.

Establishes Supply Depot

The Sullivan Machinery Co., Chicago, has established a supply depot and service station at Terre Haute, Ind. H. T. Wiley, formerly of the engineering department at Clairmont, N. H., is manager in charge.

The Self-Lock Nut Co. has purchased a plant at Constantine, Mich., which will be equipped as a malleable foundry and machine shop.

Short Turns Feature of Overhead System

A comparatively new departure in overhead trolley systems recently has been developed and placed on the market by the Whiting Corp., Harvey, Ill. The track consists of two parallel standard rolled channels spaced 2⅛ inches between flanges and held in place by clamps and is designed to carry loads with no intermediate supports except at the splices, corners and switch points. This feature will be appreciated where it may be necessary for instance to span a wide driveway. Instead of employing supports it only is necessary to use a heavier section of channel in such places.

This particular trolley system consists of the standard channels, 90-degree right switches, 90-degree left switches, 45-degree right switches, 45-degree left switches and the universal switches. Each corner and switch connection is interchangeable and therefore at any time a right corner can be removed and replaced with a double switch or a universal. All the short-turn corners and switches have a track curvature of 18 inches so that a load may be turned practically at right angles. This feature will commend itself to foundrymen who need something to serve a row of brass furnaces or machines close to the wall. It also will be appreciated in freight and terminal houses where the track can be brought out of the building and run along over the receiving platform. If necessary an extension can be thrown out to load an automobile truck. The system readily can be wired if an electric hoist is to be used instead of a chain block.

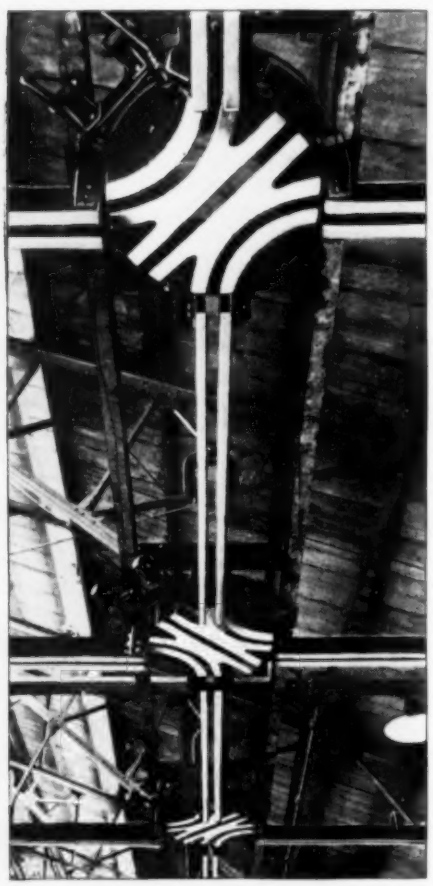

FIG. 1—UNIVERSAL SWITCHES IN SHORT TURN TROLLEY SYSTEM AS SEEN FROM BELOW

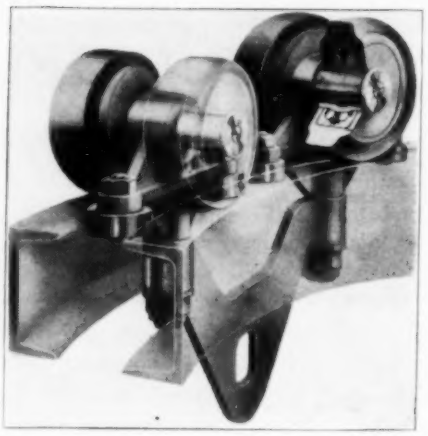

FIG. 2—TROLLEY TAKING A TURN OF 18 INCHES RADIUS

The track is built and shipped in single units which greatly reduces the cost of erection. In fact, one of the features in its favor is that since it is built from standard rolled channels or where greater strength is required, from I-beams, the material can be obtained from local stocks thus reducing the time and cost of erection.

Special 2-, 4-, or 8-wheel trolleys are provided which run on the level top of the channel tracks. They are equipped with ball bearing wheel and guide rollers which run between the toes of the channels preventing friction and rendering it impossible for the wheels to bind against the track when rounding a curve.

Preheats Cupola Fuel Oil Before Burning

Fuel oil now furnished to foundries for use in cupolas is of a heavy grade and in order to insure proper vaporization, it is necessary to preheat this oil before it goes to the burners. To accomplish this heating, the Griscom-Russell Co., 90 West street, New York, has designed a heater of the coil type. The oil is heated as it transverses two spiral coils run vertically through the heater. High pressure steam passes around the coils the condensation being returned to the boilers. Precaution must be taken to prevent contamination of the high pressure condensate by the fuel oil thus no oil joints are found inside of the steam space.

Welds Crack in Side of Bronze Bell

A bronze bell 5 feet in diameter and weighing 1650 pounds which has been hanging in the Presbyterian church tower in Denison, O., for the past 50 years and which had developed a crack in the side, recently was repaired by the oxyacetylene process in such a perfect manner that it is claimed the tone is the same as formerly. The work was done by a local firm who state that the metal 4 inches in thickness is a composition of copper and tin which chips like hard brass but welds like copper.

To avoid shrinkage cracks, while the weld was cooling it was necessary to preheat the entire bell and to minimize the cost of the job it was decided to build a temporary brick furnace around it in the belfry instead of lowering the bell to the ground. The bricks to the number of 355 were built in open formation and 15 bushels of charcoal were consumed in raising the casting to a temperature that would melt solder. The oxyacetylene torch was employed to light the charcoal and afterward a molder's bellows was used to accelerate combustion. The metal flowed almost instantly after the torch was applied.

THE BELL AS IT APPEARED AFTER THE WELD HAD BEEN COMPLETED AND POLISHED

The crack appeared on the side next to the supporting frame and it became necessary to disconnect the bell and then turn and tip it until the broken part was on top in a horizontal position. The entire crack was widened in a V-shape and then a piece of boiler plate was clamped inside the bell under the crack to prevent the molten metal from dropping through. The welding operation occupied three hours and involved the use of three cylinders of oxygen, two of acetylene and 37 pounds of bronze filling rod. After the

casting had cooled the welded surface was finished by an electric grinder.

Manufacturer of Shovels Makes Tests

To determine the best steel for shovels the Wood Shovel & Tool Co., Piqua, O. built a machine for testing shovels made of various grades of carbon and alloy steels. This machine determines not only the wear on the edge of the blade but also the wear on the surface of the blade, the strength of the weld, the toughness of the steel, or resistance to bending action, and the durability of the straps. The machine is designed with a rotating axle and four arms in which the shovels are fastened. It is driven with a 3-horsepower motor at a speed of 14 revolutions per minute. The shovels under test are forced through red granite rock.

Obituary

Thomas H. Rabe, secretary and treasurer of the Canton Malleable Iron Co., died July 15, at his home in Canton, O., at the age of 92 years. He was one of the most prominent figures in Canton industrial circles. Born in the little town of Washington, O., he moved to Pittsburgh when a boy where he spent 60 years. In 1892 he came to Canton and established the Canton Malleable Iron Co. He was a firm friend of the late President William McKinley and resided opposite him for years.

Charles F. Barnhart, 55 years old, part owner and manager of the Barnhart Davis Co., operator of a machine shop and foundry at Warren, Pa., was drowned June 30 while bathing in the Conewango creek near his cottage at North Warren. The body was recovered soon afterward but all efforts to resuscitate the victim were unavailing.

Spray Molds with Kerosene

Question—We understand several foundries throughout the country are spraying molds with atomized oil to prevent sand from adhering to the castings. Will you advise us whether the process will accomplish this end?

Answer—We know of no case where oil is sprayed on molds for this purpose. However, it is an old practice to spray kerosene on molds for heavy castings in order to assist venting. The theory is that the oil volatilizes and opens the crevices in the sand more easily than air would do. However, the beneficial effects of this process have never been definitely proved.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

The capital stock of the Industrial Casting Co., Hamilton, O., has been increased from $50,000 to $75,000.

The Nitro Foundry, Nitro, W. Va. has been incorporated for $50,000 by M. S. Aldrich, Ralph Matthews and W. A. O'Neill.

The Beacon Visible Pump Co., Louisville, Ky. has been incorporated with a capitalization of $200,000 by J. J. Kasper and A. H. VanDyke.

Fire said to be of incendiary origin damaged the plant of the H. & H. Foundry & Machine Co., Stamford, Conn.

The Akron Barrow Co., Akron, O., capitalized at $10,000, has been incorporated by Frank G. Mooney, Irwin N. Loeser, Monroe A. Loeser, Ira J. Warner and H. Stewig.

The Pennsylvania Metal Bed Co., Philadelphia, with $25,000 authorized capitalization, has been chartered. Among the incorporators is Samuel Feldman of Philadelphia.

The Oshkosh Tractor Co., Oshkosh, Wis., through Auler & Jensen, F. R. A. building, architects, is preparing plans for a 5-story factory building, 60 x 20 feet, to cost $250,000.

The Electric Thermo Co., New York City, to manufacture washing machines, capitalized at $100,000, has been incorporated by W. L. Strauss, C. C. Trautman and P. Becker.

The Richard Carter Co., Gulfport, Miss. is enlarging its plant for the manufacture of automobile, truck and tractor engines. New equipment is being purchased.

The American Washing Machine Co., Muskogee, Okla. has been incorporated with a capital stock of $25,000 by W. F. Bickford, J. M. Sims and E. V. Vernor.

The Baker Ice Machine Co., Ft. Worth, Tex. has been incorporated with a capitalization of $25,000 by H. M. Coleman, O. H. Hammer and O. J. Hocher.

Somers & Sons Co., 31st and Burleigh Sts., Milwaukee, have awarded the contract for the construction of a $10,000 foundry and machine shop building.

The General Motors Products Corp., Philadelphia, has been incorporated at $1,000,000 by F. R. Hansell, J. Vernon Pimm and E. M. MacFarland.

The Owen Thomas Engine Co., Cleveland, has been incorporated with $25,000 capital by George W. Phypers, Murray Smith, L. F. Chapman and others.

The Lindsay Foundry & Pattern Works, Ltd., Lindsay, Ont., Canada, has been incorporated with $25,000 authorized capital by Victor Swenson, Albert Anderson and Frank Byrd.

The manufacture of plumbing supplies is to be undertaken by the Moore Patents Corp., incorporated with $500,000 by C. W. Moore, H. G. Littau and others, 391 East 149th street, New York City.

The Perry Sand Co., New Lexington, O., with $30,000 capital stock, has been incorporated by Thomas O. Crossen, Edward R. Meyer, Homer E. Walters, W. M. Bell and E. K. Sprague.

The Sash Weight Foundry Co., Sand Springs, Okla, has been incorporated with a capitalization of $10,000. L. C. Hinds, A. C. Spitznagel and E. M. Taylor are the incorporators.

The Bridesburg Foundry & Engineering Co. has been incorporated with a capital stock of $125,000. Wray C. Arnold, Commonwealth building, Philadelphia, is representative of the company.

The Sterling Brass Co., St., Catherine avenue and E. 93rd St., Cleveland, is asking for bids on a brass foundry and machine shop, 145 x 200 feet. S. L. Weil is president of the company, with offices at 4610 St. Clair Ave.

The Waugh Foundry & Machine Works, Williamson, W. Va. recently let a contract for a foundry building, 50 x 150 feet, to the Truscon Steel Co., Youngstown, O. A. C. S. Waugh is president. New foundry equipment is being purchased.

Incorporation papers have been taken out by the Johnstown Steel Car & Supply Co., Johnstown, Pa., capitalized at $600,000. Mine car wheels and similar equipment will be manufactured. The incorporators were H. H. Thompson, I. Schermin and H. Earl Sorber.

Ernest McGeorge, 1900 Euclid building, Cleveland is preparing plans for machine shop and foundry, 130 x 200 feet to be erected for the Hancock Steel Co., Brocius, W. Va. F. Vernon Aken, Martinsburg, W. Va. represents the owner.

The West Virginia Foundry & Stove Works, Huntington, W. Va., will erect a foundry building, 120 x 50 feet and a warehouse, 30 x 130 feet, dismantling the present plant and installing the equipment in the new building. Frank C. Boggess is manager.

The A. H. Power Furnace Co., Ltd., Toronto, Ont., Canada, has been incorporated to manufacture stoves, furnaces, gas ranges and electrical fixtures, with $40,000 capital stock. The provisional directors are Stanley S. Mills, Vincent W. Price and Edward G. Goodwin.

The Bishop-Blaney Corp., Ltd., Paris, Ont.,

Canada, has been incorporated to carry on the business of iron founders, mechanical engineers and manufacturers of machinery. The company has been capitalized at $5,000,000 by Arthur W. Clysdale, Daniel Sedwick and Roland M. Glover, all of Peterborough, Ont.

Stringers Bros. Co., Gadsden, Ala., which is incorporated for $200,000 has a new plant under construction. The company will purchase equipment for a brass and iron foundry suitable for the production of plumbing specialties. Charles C. Stringer, 109 Dearborn St., Chicago is president and F. G. Wineman is treasurer.

New Trade Publications

FRICTION CLUTCHES—The Carlyle Johnson Machine Co., Manchester, Conn., is circulating its revised stock list of 4-pages on standard clutches now on hand for immediate shipment.

HOISTS—The Chicago Pneumatic Tool Co., New York, is circulating a 16-page illustrated booklet in which air hoists, motors and winches are described and illustrated. Complete details and specifications are given.

COMPRESSORS—Air compressors and vacuum pumps are described and illustrated in a 16-page illustrated booklet recently published by the Pennsylvania Pump & Compressor Co., Easton, Pa. These compressors and pumps are either power or steam driven, and are built in straight line and single stage types.

BURNERS—The Hauck Mfg. Co., Philadelphia, is circulating a 16-page illustrated booklet in which burners for use in foundries, boiler, machine and repair shops are described and illustrated. The burners are illustrated and described in detail, the uses to which they are put in the various shops being described, etc.

FURNACE BURNERS—A 14-page illustrated booklet is being circulated by the Hauck Mfg. Co., Philadelphia, in which furnace burners and their uses are described and illustrated. These burners use oil for fuel and are built in four different designs. They are adapted for use in industrial plants of all kinds.

CRANES—Seven and 12-ton crawling tread and road wheel locomotive cranes are described and illustrated in a small booklet recently published by the Orton & Steinbrenner Co., Chicago. The cranes are described in detail, specifications are given and the illustrations show them in actual operation.

SAND BLAST EQUIPMENT—The American Foundry Equipment Co., New York, has published a 28-page illustrated booklet in which sand blasting equipment, such as rotary table rooms, automatic tables, revolving barrels, blast cabinets, pressure tanks, dust arresters and accessory equipment, is described and illustrated.

CRANES—Locomotive cranes are described and illustrated in a large booklet recently issued by the Browning Co., Cleveland. The first part of the booklet is devoted to describing the cranes, while the last part is devoted to illustrations showing the cranes at work in various industries engaged in different work.

SAND CUTTING MACHINE—The American Foundry Equipment Co., New York, is circulating a 48-page booklet in which testimonial letters from users of the company's sand cutting machines are given. The various letters are from practically all parts of the country and are representative of the largest foundry operators' opinions of the sand cutting machines.

ELECTRIC HOISTS—The Electric Hoist Manufacturers' association, New York, has published a 12-page illlustrated bulletin in which approved applications of electric hoists are given. The list to which such hoists have been put to use successfully includes automobile manufacturing plants, airplane factories, bolt, nut and screw plants, brass and copper mills, brick yards, by-product plants, car manufacturing plants, repair shops, chemical plants, electric light and power plants, enameling plants, forging plants, foundries and numerous others.

FLEXIBLE SHAFTING—N. A. Strand & Co., Chicago, is circulating a 28-page illustrated booklet in which flexible shafts and equipment are described and illustrated. With this equipment, according to the folder, grinding, polishing, sanding, drilling, reaming, tapping, tire buffing, nut setting, screw driving, and other operations, may be done rapidly and accurately.

FANS—A small folder has been published by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., in which fans are described and illustrated. The folder is in two colors. Some of the uses to which these fans are put include removing of smoke, steam, foul air, hot air, dust, gases, etc., and are used in all lines of industry, both in shops and offices.

CONTROL APPARATUS—A descriptive leaflet on control apparatus is being distributed by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. In this leaflet the type F magnetic-switch double-section control panels are featured, as well as the type 22-F magnetic-switch control panels. Nine diagrams and dimension diagrams of apparatus are given.

CRANES—Alfred Box & Co., Inc., Philadelphia, has published a 32-page illustrated booklet in which electric traveling cranes are described and illustrated. Detailed descriptions of the various parts of these cranes are given and one section of the booklet contains a number of illustrations showing actual installations.

DRILL STANDS—A 4-page illustrated folder has been published by the Independent Pneumatic Tool Co., Chicago, in which a stand for a portable electric drill is described and illustrated. By the use of this stand a portable electric drill can be converted into an accurate sensitive drill, doing the work of a modern drill press. Specifications are given.

OIL BURNERS—The George J. Hagan Co., Pittsburgh, is circulating a 14-page illustrated booklet in which oil burners and combination oil and gas burners for industrial furnace application, are described and illustrated. The equipment is described in detail and specifications, etc., are given. The illustrations include a number of line drawings.

COMPRESSOR—The Pittsburgh Reinforced Brazing & Machine Co., Pittsburgh, is circulating a 4-page illustrated leaflet in which high pressure oxygen compressors are described and illustrated. These compressors have a capacity of 45 cubic feet of free oxygen per minute, or 2700 square feet per hour, compressing the same at 2000 pounds pressure per square inch. Full details and specifications are given.

GRINDING MACHINES—Cylindrical grinding machines, open side surface grinding machines, car wheel grinding machines, tool room grinding machines, roll grinding machines, running balance indicating machines, grinding wheel stands, and grinding wheel attachments, are described and illustrated in a 32-page illustrated booklet recently published by the Norton Co., Worcester, Mass.

FURNACES—Electric heat treating and annealing furnaces are described and illustrated in a 16-page illustrated booklet published by Holcroft & Co., Detroit. These furnaces are designed to operate from standard power circuits. The information given in the booklet is interesting and valuable to those whose problems of manufacture include that of heat treating and annealing of either ferrous or nonferrous metals.

ELEVATOR CONTROLLERS—A large 40-page illustrated booklet has been published by the Cutler-Hammer Mfg. Co., Milwaukee, in which elevator controllers are described and illustrated. According to the booklet the salient features of these controllers are: Renewable carbon to copper power contacts; a constant time element type of acceleration; quiet, sure-operating magnetic contactors; simple construction with few auxiliary interlocking contacts. The controllers are described in detail.

ELECTRIC HOISTS—The Sprague Electric Works of the General Electric Co., Schenectady, N. Y., is circulating a 24-page illustrated booklet in which electric hoists and parts are described and illustrated. These hoists are built in capacities of from ¼ of a ton to 6 tons and in two general types: One being worm geared and the other spur geared. Both types are operated either on direct current and polyphase alternating current circuits. Full details are given and the illustrations show actual installations. Specifications are given.

CRANES—The Northern Engineering Works, Detroit, has published a 4-page illustrated circular in which its type E cranes are described and illustrated. Some of the features of these cranes are: Entirely enclosed gears; cast steel gears; forged steel pinions; transmission type of gearing; two-bearing shafts; shafts do not extend across trolley; hoisting gear train from armature to drum is in one cast frame; no overhung gears and specially constructed footwalk; double breaks on hoist; quick acting foot-brake on bridge; structural girt between trolley frames; positive type direct-acting automatic hook-limit stop and motors and controllers of standard makes.

ALLOY STEELS—A shop handbook on alloy steels, prepared by G. Van Dyke, manager of the special steel department of Joseph T. Ryerson & Son, Chicago, is being circulated by the company. The subject matter of the booklet deals exclusively with alloy steels and although a technical subject, is treated in a nontechnical way, in that so far as possible all technicalities, etc., are avoided. In a few words the booklet is a plain, concise and condensed handbook of information on alloy steels for the average shop superintendent and foreman. The information given is interesting and valuable, and in addition pen etchings throughout the booklet add color to it.

CHARGING TRUCK—A pneumatic truck for charging annealing ovens is described and illustrated in an 8-page illustrated booklet recently published by the American Foundry Equipment Co., New York. This truck operates by a high grade reciprocating type air motor. The drive transmission comprises a standard motor truck differential, the shafts of which carry a steel pinion in engagement with internal gears in the periphery of the two forward wheels. Air is supplied by a flexible hose connection. A throttling pedal controls the motor speed, and a hand lever the direction. Steering is by a standard motor truck hand-wheel. With this truck, short turns may be made. Compressed air raises and lowers the steel tongs which carry the load and a convenient hand lever admits or discharges pressure to an air cylinder.